CHAPTER 4. ENVIRONMENTAL IMPACTS

Chapter 4 describes the potential environmental consequences to the SRS and the surrounding region of implementing each of the alternatives described in Chapter 2. As discussed in Chapter 2, DOE has identified three alternatives and three tank stabilization options:

- No Action Alternative
- Clean and Stabilize Tanks Alternative
  - Clean and Fill with Grout Option (Preferred Alternative)
  - Clean and Fill with Sand Option
  - Clean and Fill with Saltstone Option
- Clean and Remove Tanks Alternative

Environmental consequences of actions could include direct physical disturbance of resources, consumption of affected resources, and degradation of resources caused by effluents and emissions. Resources include air, water, soils, plants, animals, cultural artifacts, and people, including SRS workers and people in nearby communities. Consequences may be detrimental (e.g., increased airborne emissions of hazardous chemicals) or beneficial (e.g., jobs created by new construction).

Section 4.1 describes the short-term impacts associated with each alternative within the scope of this EIS. For purposes of the analyses in the EIS, the short-term impacts span from the year 2000 through final closure of the existing HLW tanks associated with operation of the DWPF (approximately 2030). Section 4.2 describes the long-term impacts of the residual radioactive and non-radioactive material in the closed HLW tanks. Long-term assessment involves a 10,000-year performance evaluation beginning with a 100-year period of institutional control and continuing through an extended period during which it is assumed that residents and intruders could be present.

The impact assessments in this EIS have generally been performed in such a way that the magnitude and intensity of estimated impacts are unlikely to be exceeded during either normal operations or in the event of an accident. For routine operations, the results of monitoring the impacts from actual operations provide realistic predictions of impacts. For accidents there is more uncertainty because the impacts are based on events that have not occurred. In this EIS, DOE selected hypothetical accidents that would produce impacts as severe or more severe than any reasonably foreseeable accidents, which bounds the impacts of all reasonably foreseeable accidents for each alternative. The use of this methodology ensures that all of the alternatives have been evaluated using the same methods and data, allowing a non-biased comparison of impacts.

To ensure that small potential impacts are not over-analyzed and large potential impacts are not under-analyzed, analysts have assessed potential impacts based on their significance. This methodology follows the recommendation for the use of a "sliding scale" approach to analysis described in *Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements* (DOE 1993). The sliding scale approach uses a determination of significance by the analyst (and, in some cases, peer reviewers) for each potential impact. Potential impacts determined to be insignificant are not analyzed further, while potential impacts that may be significant are analyzed at a level of detail commensurate with the magnitude of the impacts.

4.1 Short-Term Impacts

Section 4.1 describes the short-term impacts associated with each alternative. For purposes of the analyses in the EIS, the short-term impacts span from year 2000 through final closure of the existing HLW tanks associated with operation of the DWPF (approximately 2030). The structure of Section 4.1 closely parallels that of Chapter 3, Affected Environment, with the addition of sections on utilities and energy consumption and accidents. The sections discuss methodology and present the potential impacts of each alternative evaluated. More details on the methodology for accident analysis are provided in Appendix B.

4.1.1 GEOLOGIC RESOURCES

No geologic deposits within F- and H-Areas have been economically or industrially developed, and none are known to have significant potential for development. There are, however, four tanks in F-Area and four tanks in H-Area that would require backfill soil to be placed over the top of the tanks for the Clean and Stabilize Tanks Alternative. The backfill soil would bring the ground surface at these tanks up to the surrounding surface elevations to prevent surface water from collecting in the surface depressions. This action would prevent ponded conditions over these tanks that could facilitate the degradation of the tank structure. DOE currently estimates that 170,000 cubic meters of soil would be required to fill the depressions to grade.

Under the Clean and Remove Tanks Alternative, the tanks would be cleaned as appropriate and removed from the subsurface. This would require the backfilling of the excavations left by the removal of the tanks. The backfill material would consist of a soil type similar to the soils currently surrounding the tanks. DOE currently estimates that 356,000 cubic meters of soil would be required to backfill the voids left by the removal of the tanks.

The backfill soils would be excavated from an onsite borrow area(s) as determined by DOE. The excavation of borrow soils would be performed under Best Management Practices to limit impact to geologic resources that may be present. As a result, there would be no short-term impacts at the individual tank locations to geologic resources from any of the proposed alternatives discussed in Chapter 2.

4.1.2 WATER RESOURCES

4.1.2.1 Surface Water

Surface runoff in F- and H-Area Tank Farms flows to established storm sewer systems that may be used to block, divert, re-route, or hold up flow as necessary. During periods of earth moving or soil excavating, surface water runoff can be routed to area stormwater basins to prevent sediment from moving into down-gradient streams. During phases of the operation when the potential for a contaminant spill exists, specific storm sewer zones (or "flowpaths") can be secured, ensuring that contaminated water or cleaning chemicals inadvertently spilled would be routed to a lined retention basin via paved ditches and underground drainage lines.

The retention basins are flat-bottomed, slope-walled, earthen basins lined with rubber (H-Area Retention Basin) or polyethylene (F-Area Retention Basin). Both basins have a capacity of 6,000,000 gallons. Stormwater in the retention basins may be sent to Fourmile Branch (if uncontaminated rainwater), to the Effluent Treatment Facility for removal of contaminants, or rerouted to the tank farms for temporary storage prior to treatment. Because any construction site runoff or spills would be controlled by the tank farm storm sewer system, DOE does not anticipate impacts to down-gradient surface waters. Activities would be confined to developed areas and discharges would be in compliance with existing stormwater permits.

Small (approximately one acre) lay-down areas would be established just outside of the F- and H-Area Tank Farms to serve as equipment storage and staging areas. Development of these lay-down areas would require little or no construction or land disturbance; therefore, the potential for erosion and sedimentation under any of the alternatives would be negligible.

Prior to construction, DOE would review and augment (if necessary) its existing erosion and sedimentation plans, ensuring that they were in compliance with State regulations on stormwater discharges and approved by SCDHEC.

4.1.2.2 Groundwater

The only direct impact to groundwater resources during the short-term activities associated with tank closure would be the use of groundwater for cleaning, for tank ballast, and for mixing grout, saltstone, or sand fill. Of the alternatives described in Chapter 2, only the No Action Alternative involves using water as ballast; however, this alternative does not use water for tank cleaning. The Grout and Saltstone Options under the Clean and Stabilize Tanks Alternative include water use for tank cleaning and for mixing with the grout and saltstone backfill. The Clean and Fill with Sand Option uses water for tank cleaning and a relatively small amount of water to prepare the sand slurry for tank filling. The Clean and Remove Tanks Alternative only uses water for cleaning, although the higher degree of cleaning required for tank removal would use more water than cleaning for in-place tank closure alternatives.

An accounting of the volumes of water required for each of the closure alternatives (as described in Section 4.1.11) shows that the largest volume of water would be used during the Clean and Stabilize Tanks Alternative (Grout Option). The largest volume on a per tank basis would be consumed during closure of Type III tanks. Based on the anticipated closure schedule, closure of two Type III tanks in any given year would consume approximately 2.3 million gallons of water. This water would come from the groundwater production wells located at various operating areas at SRS. As a comparison, the total groundwater production from the F-Area industrial wells from January through December 1998 was approximately 1.01 million gallons per day (370 millions gallons per year) (Johnson 1999). This water was pumped from the intermediate and deep aquifers that have been widely used as an industrial and municipal groundwater source for many years across Aiken County. The tank closure water requirements represent less than 0.6 percent of the F-Area annual production alone. Based on these projections, there would be no significant impact to groundwater resources for any of the tank closure alternatives.

The tank farms are situated in highly developed industrial areas. Some of the tank groups were constructed in pits substantially lower in elevation than the surrounding terrain. The existing tank farm sites include facilities and structures designed to prevent surface ponding and to manage precipitation runoff in a controlled manner. Reclamation of the tank farms after closure would require backfilling and grading to provide a suitable site for future industrial/commercial development, to prevent future ponding of water at the surface, and to promote non-erosional surface water runoff. Backfilling and grading would be performed using borrow material derived from local areas at the SRS; borrow material is assumed to be physically similar to the in-place materials. Therefore, there should be little or no impact to short-term groundwater recharge as a result of the surface reclamation activities.

The in-place tank closure alternatives would result in residual waste being left in the tanks. The residual waste has the potential to contaminate groundwater at some point in the future due to leaching and water-borne transport of contaminants. This is not expected to occur, however, until several hundred years after tank closure when the tank, tank contents, and underlying basemat are anticipated to fail due to deterioration. Under all closure alternatives, construction and/or demolition activities have the potential to result in soil, wastewater, or direct groundwater contamination through spills of fuels or chemicals or construction by-products and wastes. By following safe work practices and implementing good engineering methodologies, concentrations in soil, wastewater, and groundwater should be kept well within applicable standards and guidelines to protect groundwater resources.

4.1.3 AIR RESOURCES

This section discusses nonradiological and radiological air quality impacts that would result from actions related to tank closure activities. To determine the impacts on air quality, DOE estimated the emission rates associated with processes used in each alternative. This included an identification of potential emission sources and any methods by which air would be filtered before being released to the environment. These emissions were entered into air dispersion models to determine potential maximum concentrations at onsite and offsite locations. The estimated emissions and air concentrations of nonradiological and radiological pollutants are discussed and compared to the pertinent SCDHEC and Federal regulatory limits in the following two sections. Any human health effects resulting from increased air concentrations are discussed in the Worker and Public Health Section (4.1.8).

4.1.3.1 Nonradiological Air Quality

Tank closure activities would result in the release of regulated nonradiological pollutants to the surrounding air. The estimated emission rates (tons per year) for each emitted regulated pollutant and each alternative/option are presented in Table 4.1.3-1. These emission rates can be compared against emission rates defined in SCDHEC Standard 7, "Prevention of Significant Deterioration (PSD)." The PSD limits are included in Table 4.1.3-1 and are discussed in this section.

The primary sources of nonradiological air pollutants for the Grout Option under the Clean and Stabilize Tanks Alternative would be a concrete batch plant located next to each of the F- and H-Area Tank Farms and three diesel generators that would provide electrical power for each of these batch plants. The batch plants and generators were assumed to be identical to those used during the two previous tank closures and were conservatively assumed to run continuously. The diesel generators account for a majority of the pollutants emitted; however, the batch plants' emissions would account for 77 percent of the total PM_{10} (particulate matter with an aerodynamic diameter ≤ 10 μm) emitted. Additional nonradiological pollutants would be expected from the exhaust from trucks delivering raw materials to the batch plant every few days. Since these emissions would only occur occasionally, they were considered very small relative to batch plant emission and were not included in the emissions calculations for this option or any other option under the Clean and Stabilize Tanks Alternative.

For the Sand Option of the Clean and Stabilize Tanks Alternative, nonradiological pollutants would be emitted from operation of the sand conveyance (feed) plants, one at H-Area and a second at F-Area, and three diesel generators providing electric power for each of the sand conveyance plants. The sand feed plants would emit 67 percent of the total PM_{10} that would be emitted under this option. The diesel generators and sand conveyance plants were assumed to operate continuously.

The option of filling the cleaned tanks with saltstone would require saltstone batching facilities to be located at F- and H-Areas. The total amount of saltstone that would be made from the stabilization of all the low-activity fraction of HLW would probably be greater than the capacity of the waste tanks (DOE 1996). Therefore, each of the two new facilities for producing the saltstone necessary to fill the tanks was assumed to be one-half the size of the existing facility and was assumed to have identical sources of air pollution (Hunter 1999). The diesel generator emissions were based on the permitted emissions for the three generators at the Saltstone Manufacturing and Disposal Facility.

Regulated nonradiological air pollutants released as a result of activities associated with the No Action Alternative would consist primarily of emissions from vehicular traffic operating during waste removal. Relatively few vehicles would be required and would not run continuously; therefore, the emissions would be very small.

Regulated nonradiological air pollutants released as a result of activities associated with the Clean and Remove Tanks Alternative would consist of emissions from cutting the carbon steel tanks and emissions from vehicular traffic operating during cleaning and removal. The tank cutting would produce particulates, but not air toxics, and these particulates would be heavier and deposited to the ground much quicker than for welding. The cutting operations would be intermittent and short term (a day or two every few weeks). Also, a hut would be erected around the cutting operation to control the particulates; therefore the emissions would be very

Table 4.1.3-1. Nonradiological air emissions (tons per year) for tank closure alternatives.[a]

			Diesel Generators			Batch/Feed Plant			
Air pollutant	PSD significant emissions rate[b]	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	Clean and Remove Tank Alternative
Sulfur dioxide (as SO_x)	40	-[c]	2.2	2.2	6.6				-[c]
Total suspended particulates	25	-[c]	-[d]	-[d]	5.2				-[c]
Particulate matter (≤10 µm)	15	-[c]	1.0	1.0	3.3	3.5	2.1	0.3	-[c]
Carbon monoxide	100	-[c]	5.6	5.6	16.0				-[c]
VOCs	40	-[c]	2.3	2.3	4.9			0.8	-[c]
Nitrogen dioxide (as NO_x)	40	-[c]	33	33	77				-[c]
Lead	0.6	-[c]	9.0×10^{-4}	9.0×10^{-4}	2.9×10^{-3}				-[c]
Beryllium	4.0×10^{-4}	-[c]	1.7×10^{-4}	1.7×10^{-4}	5.6×10^{-4}				-[c]
Mercury	0.1	-[c]	2.2×10^{-4}	2.2×10^{-4}	7.0×10^{-4}			8.4×10^{-5}	-[c]
Benzene	NA	-[c]	0.02	0.02	0.04			0.84	-[c]

NA = Not applicable; no regulatory limit for this pollutant.
Source: Hunter (1999).
b. SCDHEC, Regulation 61-62.5, Standard 7, "Prevention of Significant Deterioration (PSD), Part V(1)."
c. Emissions from these alternatives have not been quantified, but would be small in relation to the clean and Stabilize Tanks Alternative.
d. No data on TSP emissions for these sources are readily available and therefore are not reflected in this analysis.
e. VOCs = volatile organic compounds, includes benzene.

small. Relatively few vehicles would be required and would not run continuously.

Additionally, all but one alternative includes the possibility of cleaning the interior tank walls with oxalic acid, a toxic air pollutant regulated under SCDHEC Standard 8. Oxalic acid would likely be stored in aboveground storage tanks. Tank ventilation would result in the release of small amounts of vapor to the atmosphere. A review of emissions data from two oxalic acid tanks currently used at SRS shows that the emissions from these sources are less than 3.5×10^{-9} tons per year. This resulting concentration in the vented air would be much less than any ambient air limit and would therefore be considered to be very small for purposes of assessing impacts to air quality (Hunter 1999).

The oxalic acid would be stored as a 4-8% (by weight) solution in tank trucks and driven to the tank to be cleaned. The acid would be transferred to the HLW tanks through a sealed pipeline. No releases are expected during this procedure. The cleaning process would consist of spraying hot (80-90°C) acid using remotely operated water sprayers. The tanks would be ventilated with 300-400 cfm of air, which would pass through a HEPA filter. The acid has a very low vapor pressure (as demonstrated by the very low tank emissions), releases from the ventilated air will be minimal. After its use in the tank, the acid is pumped and neutralized. Although no specific monitoring for oxalic acid fumes was performed during the cleaning of Tank 16 (see Sect. 2.1.1), no deleterious effects of using the acid were noted at the time.

The expected emission rates from the identified sources for each alternative/option were compared to the emission rates listed in SCDHEC Standard 7, "Prevention of Significant Deterioration (PSD)," to determine if the emission would result in an exceedance of this standard or a significant emission increase. Facilities such as SRS that are located in attainment areas and are classified as major facilities may trigger a PSD permit review under the new source review requirements of the Clean Air Act when they construct a major stationary source or make a major modification to a major source. A major source is defined as a source with the potential to emit any air pollutant regulated under the Clean Air Act in amounts equal to or exceeding specified thresholds. A PSD permit review is required if that modification or addition to the major facility results in a significant net emissions increase of any regulated pollutant. However, as can be seen in Table 4.1.3-1, the expected nonradiological emissions would be below the PSD significant emission rates listed in Standard 7 for most pollutants. The estimated emission rate for oxides of nitrogen under each alternative (33, 33, and 77 tons per year) are close to or exceed the PSD limit of 40 tons per year. However, the estimated emission rates were based on the assumption that batch operations at both F-Area and H-Area are running at the same time and continuously throughout the year. In all likelihood, tanks would be closed one at a time and there would be time between each closure when equipment is not in operation. Therefore, the estimated emission rates in Table 4.1.3-1 are conservative and none would be expected to exceed the PSD limits in Standard 7. In addition, the estimated emission rate for beryllium from diesel generators for the Clean and Fill with Saltstone Option would slightly exceed the PSD significant emissions rate.

Using the emission rates from Table 4.1.3-1, maximum concentrations of released regulated pollutants were determined using the EPA's Industrial Source Complex – Short Term (ISC3) air dispersion model (EPA 1995). The one-year meteorological data set collected onsite at SRS for 1996 was used as input into the model. Maximum concentrations were estimated at: (1) the SRS boundary where members of the public potentially could receive the highest exposure, and (2) at the location of a hypothetical noninvolved site worker. For the location of the noninvolved worker, the analysis used a generic location 2,100 feet from the release point in the direction of the greatest concentration. This location is the standard distance for assessing consequences from facility accidents and is used here for normal operations for consistency. Concentrations at the receptor locations were calculated at an elevation of 2 meters above ground to approximate the breathing height of a typical adult. The maximum air concentrations (micrograms per cubic meter) at the SRS boundary associated with the release of regulated nonradiological pollutants are listed in Tables 4.1.3 2 and 4.1.3-3. As can be expected, the Clean and Fill with Saltstone Option, which has slightly higher emissions, results in higher concentrations at the site boundary. However, ambient concentrations for all the pollutants and alternatives/options would increase by less than 1 percent of the regulatory limits. Therefore, no proposed tank closure activities would result in an exceedance of standards.

The air quality impacts at the location of a hypothetical noninvolved worker in the vicinity of F- and H-Areas are presented in Table 4.1.3-4. As with the modeled concentrations at the Site boundary, ambient concentrations of the OSHA-regulated pollutants (milligrams per cubic meter) at the location of the noninvolved worker would be highest for the Clean and Fill with Saltstone Option. All concentrations would be below OSHA limits; all concentrations with the exception of nitrogen dioxide (as NO_x) would be less than 1 percent of the regulatory limit. Nitrogen dioxide (as NO_x) could reach 8 percent of the regulatory limit for the Clean and Fill with Grout and Clean and Fill with Sand Options while nitrogen dioxide levels under the Clean and Fill with Saltstone Option could reach approximately 16 percent of the OSHA limit. All emissions of nitrogen dioxide are attributable to the operation of the diesel generators.

Emissions of regulated nonradiological air pollutants resulting from tank closure activities would not exceed PSD limits enforced under SCDHEC Standard 7. Likewise, air concentrations at the SRS boundary of the emitted pollutants under all options would not exceed SCDHEC or Clean Air Act regulatory limits. Any impacts to human health from these pollutants are discussed in Section 4.1.8.2 – Nonradiological Health Effects.

Table 4.1.3-2. Estimated maximum concentrations (in micrograms per cubic meter) at the SRS boundary for SCDHEC Standard 2 Air Pollutants.[a]

Air pollutant	Averaging time	South Carolina Standard[b]	SRS baseline[c]	Maximum concentration increement: No Action Alternative	Clean and Stabilize Tanks Alternative: Clean and Fill with Grout Option	Clean and Stabilize Tanks Alternative: Clean and Fill with Sand Option	Clean and Stabilize Tanks Alternative: Clean and Fill with Saltstone Option	Clean and Remove Tanks Alternative
Sulfur dioxide (as SO_x)	3-hr	1,300	1,200	(d)	0.2	0.2	0.6	(d)
	24-hr	365	350	(d)	0.04	0.04	0.12	(d)
	Annual	80	34	(d)	0.002	0.002	0.006	(d)
Total suspended particulates	Annual Geometric Mean	75	67	(d)	ND	ND	0.005	(d)
Particulate matter (≤10 µm)	24-hr	150 (65)[e]	130	(d)	0.08	0.06	0.06	(d)
	Annual	50 (15)[e]	25	(d)	0.004	0.003	0.003	(d)
Carbon monoxide	1-hr	40,000	10,000	(d)	1.2	1.2	3.4	(d)
	8-hr	10,000	6,900	(d)	0.3	0.3	0.8	(d)
VOCs	1-hr	(f)	(f)	(d)	0.5	0.5	2.0	(d)
Ozone	1-hr	235	NA	(d)	(g)	(g)	(g)	(d)
Nitrogen dioxide (as NO_x)	Annual	100	26	(d)	0.03	0.03	0.07	(d)
Lead	Calendar Quarter Mean	1.5	0.03	(d)	1.2×10^{-6}	1.2×10^{-6}	4.1×10^{-6}	(d)

NA = Not applicable; ND = Not detectable; maximum concentration below detectable limit; VOC = volatile organic compounds.

a. Source: Hunter (1999).

b. Source: SCDHEC Air Pollution Regulation 61-62.5, Standard 2, "Ambient Air Quality Standards."

c. Sum of (1) an estimated maximum site boundary concentration from modeling all sources of the indicated pollutant at SRS not exempt from Clean Air Act Title V modeling requirements (maximum potential emissions from the 1998 Air Emissions Inventory data base) and (2) observed concentrations from nearby ambient air monitoring stations.

d. No emissions of this pollutant are expected.

e. New NAAQS for particulate matter ≤2.5 microns (24-hour limit of 65 $\mu g/m^3$ and an annual average limit of 15 $\mu g/m^3$) may become enforceable during the life of this project.

f. There is no standard for ambient concentrations of volatile organic compounds, but their concentrations are relevant to estimating ozone concentrations.

g. Ozone is a regional pollutant resulting from complex photochemical reactions involving oxides of nitrogen (NO_x) and volatile organic compounds (VOCs). Because estimated NO_x and VOCs emissions are below Prevention of Significant Deterioration (PSD) significant emissions rates, corresponding ozone increases are expected to be insignificant.

Table 4.1.3-3. Estimated maximum concentrations (in micrograms per cubic meter) at the SRS boundary for SCDHEC Standard 8 Toxic Air Pollutants.

				Maximum concentration increment				
					Clean and Stabilize Tanks Alternative			
Air pollutant	Averaging time	South Carolina Standard[a]	SRS baseline[b]	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	Clean and Remove Tanks Alternative
Beryllium	24-hr	0.01	0.009	(c)	3.2×10^{-6}	3.2×10^{-6}	1.1×10^{-5}	(c)
Mercury	24-hr	0.25	0.03	(c)	4.0×10^{-6}	4.0×10^{-6}	1.6×10^{-5}	(c)
Benzene	24-hr	150	4.6	(c)	3.8×10^{-4}	3.8×10^{-4}	2.0×10^{-2}	(c)

a. From SCDHEC Air Pollution Regulation 61-62.5, Standard 8, Part II, Paragraph E, "Toxic Air Pollutants."
b. Estimated maximum site boundary concentrations from modeling all sources of the indicated pollutant at SRS not exempt from Clean Air Act Title V modeling requirements (maximum potential emissions from the 1998 Air Emissions Inventory database).
c. No emissions of this pollutant are expected.

Table 4.1.3-4. Estimated maximum concentrations (in milligrams/cubic meter) of OSHA-regulated nonradiological air pollutants at hypothetical noninvolved worker location.

			Maximum concentration[b]				
			Clean and Stabilize Tanks Alternative				
Air pollutant	Averaging time	OSHA Standard[a]	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	Clean and Remove Tanks Alternative
Sulfur dioxide (as SO_x)	8-hr TWA	13	-	5.0×10^{-3}	5.0×10^{-3}	0.02	-
Total suspended particulates	8-hr TWA	15	-	ND	ND	0.01	-
Particulate matter (≤10 μm)	8-hr TWA	5	-	9.0×10^{-3}	6.0×10^{-3}	8.0×10^{-3}	-
Carbon monoxide	8-hr TWA	55	-	0.01	0.01	0.04	-
Oxides of nitrogen (as NO_x)	Ceiling	9	-	0.7	0.7	1.4	-
Lead	8-hr TWA	0.05	-	2.1×10^{-6}	2.1×10^{-6}	6.5×10^{-6}	-
Beryllium	8-hr TWA	2.0×10^{-3}	-	4.1×10^{-7}	4.1×10^{-7}	1.3×10^{-6}	-
	Ceiling	5.0×10^{-3}	-	3.4×10^{-6}	3.4×10^{-6}	1.1×10^{-5}	-
Mercury	Ceiling	1.0		4.2×10^{-6}	4.2×10^{-6}	1.4×10^{-5}	-
Benzene	8-hr TWA	3.1	-	4.8×10^{-5}	4.8×10^{-5}	1.0×10^{-3}	-
	Ceiling	15.5	-	3.9×10^{-4}	3.9×10^{-4}	3.3×10^{-3}	-

ND = Not detectable; maximum concentration below detectable limit.

a. Air pollutants regulated under 29 CFR 1910.1000. Averaging values listed are 8-hour time-weighted averages (TWA) except for oxides of nitrogen, mercury, benzene, and beryllium which also include not-to-be exceeded ceiling (29 CFR 1910.1000 values).

b. Hunter (1999). Maximum estimated concentrations for a noninvolved worker at a distance of 2,100 feet from source and a breathing height of 2 meters.

4.1.3.2 Radiological Air Quality

Routine radiological air emissions that would be associated with tank closure activities were assumed to be equivalent to the current level of releases from the F- and H-Area Tank Farms. Annual emissions were based on the previous 5 years measured data for the tank farms (predominantly Cs-137). For No Action and each of the fill alternatives, all the air exiting the tanks would be filtered through high efficiency particulate air (HEPA) filters. For the Clean and Remove Tanks Alternative, the top of the tank would have HEPA-filtered enclosures or airlocks during removal of the metal from the tank. The tank would remain under negative pressure during cutting operations, and the exhaust would be filtered through HEPA filtration (Johnson 1999). Therefore, emissions from the tanks in F-Area and H-Area would not vary substantially among alternatives. The Saltstone Option under the Clean and Stabilize Tanks Alternative would require two new saltstone mixing facilities that would result in additional radionuclide emissions. The estimated Saltstone Manufacturing and Disposal Facility radionuclide emission rates presented in the *DWPF Supplemental EIS* (DOE 1994) were assumed to bound the emissions from both saltstone mixing facilities. The total estimated radiological air emissions for each alternative are shown in Table 4.1.3-5. The relevance to human health of these emissions are presented in Section 4.1.8 – Worker and Public Health.

After determining routine emission rates, DOE used the MAXIGASP and POPGASP computer codes to estimate radiological doses to the maximally exposed individual, the hypothetical noninvolved worker, and the offsite population surrounding SRS. Both codes utilize the GASPAR (Eckerman et al. 1980) and XOQDOQ (Sagendorf et al. 1982) modules that have been adapted and verified for use at SRS (Hamby 1992 and Bauer 1991, respectively). MAXIGASP and POPGASP are both site-specific computer programs that have SRS-specific meteorological parameters (e.g., wind speeds and directions) and population distribution parameters (e.g., number of people in sectors around the Site). The 1990 census population database was used to represent the population living within a 50-mile radius of the center of SRS.

Table 4.1.3-6 presents the calculated maximum radiological doses associated with tank closure activities for all the analyzed alternatives and options. Based on the dispersion modeling, the maximally exposed individual was identified as being located in the northern sector at the SRS boundary (Simpkins 1996). The maximum committed effective dose equivalent for the maximally exposed individual would be 2.6×10^{-5} millirem per year for the Clean and Fill with Saltstone Option, which is slightly higher than the other alternatives due to the additional emissions from operation of the saltstone batch plants. A majority of the dose to the maximally exposed individual, 70 percent, is associated with emissions from the tanks in H-Area. The annual maximally exposed individual dose under all the alternatives is well below the established annual dose limit of 10 millirem for SRS atmospheric releases (40 CFR 61.92). The maximum estimated dose to the offsite population residing within a 50-mile radius is calculated as 1.5×10^{-3} person-rem per year for the Clean and Fill with Saltstone Option. As with the maximally exposed individual dose, the tank farm emissions from H-Area comprise a majority (71 percent) of the total dose.

Table 4.1.3-6 also reports a dose to the hypothetical onsite worker from the estimated annual radiological emissions. The Clean and Fill with Saltstone Option is slightly higher than the other alternatives, 2.64×10^{-3} versus 2.57×10^{-3} millirem per year, with 74 percent of the total dose due to emissions from the H-Area Tank Farm.

Radionuclide doses from tank closure activities for all alternatives and options considered would not exceed any regulatory limit. Potential human health impacts from these doses are presented in Section 4.1.8.

Table 4.1.3-5. Annual radionuclide emissions (curies/year) resulting from tank closure activities.

	Annual emission rate				
		Clean and Stabilize Tanks Alternative			
	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	Clean and Remove Tanks Alternative
F-Area [a]	3.9×10^{-5}	3.9×10^{-5}	3.9×10^{-5}	3.9×10^{-5}	3.9×10^{-5}
H-Area [a]	1.1×10^{-4}	1.1×10^{-4}	1.1×10^{-4}	1.1×10^{-4}	1.1×10^{-4}
Saltstone Facility[b]	NA	NA	NA	0.46	NA
Total	1.5×10^{-4}	1.5×10^{-4}	1.5×10^{-4}	0.46	1.5×10^{-4}

a. Source: Arnett and Mamatey (1997 and 1998), Arnett (1994, 1995, and 1996).
b. Source: DOE (1994).

Table 4.1.3-6. Annual doses from radiological air emissions from tank closure activities.[a]

	Maximum dose				
		Clean and Stabilize Tanks Alternative			
	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	Clean and Remove Tanks Alternative
Noninvolved worker dose (millirem/year)	2.6×10^{-3}	2.6×10^{-3}	2.6×10^{-3}	2.6×10^{-3}	2.6×10^{-3}
Maximally exposed individual dose (millirem/year)	2.5×10^{-5}	2.5×10^{-5}	2.5×10^{-5}	2.6×10^{-5}	2.5×10^{-5}
Offsite population dose (person-rem/year)	1.4×10^{-3}	1.4×10^{-3}	1.4×10^{-3}	1.5×10^{-3}	1.4×10^{-3}

a. Source: Based on emissions values listed in Table 4.1.3-5 and Simpkins (1996).

4.1.4 ECOLOGICAL RESOURCES

Most of the closure activities described in Chapter 2 (e.g., excavation and removal of transfer lines) would take place within the fenced boundaries of the F- and H-Area Tank Farms, heavily industrialized areas that provide limited wildlife habitat (see Figures 3.5-1 and 3.5-2). However, wildlife in undeveloped woodland areas adjacent to the F- and H-Area Tank Farms could be intermittently disturbed by construction activity and noise over the approximately 30-year period when 49 HLW tanks would be emptied (under all alternatives, including No Action), cleaned and stabilized (under the Clean and Stabilize Tanks Alternative), or cleaned and removed (under the Clean and Remove Tanks Alternative).

Construction would involve the movement of workers and construction equipment and would be associated with relatively loud noises from earth-moving equipment, portable generators, cutting tools, drills, hammers, and the like. Although noise levels in construction areas could be as high as 110 dBA, these high local noise levels would not extend far beyond the boundaries of the project sites.

Table 4.1.4-1 shows the attenuation of construction noise over relatively short distances. At

Table 4.1.4-1. Peak and attenuated noise (in dBA) levels expected from operation of construction equipment.[a]

Source	Noise level (peak)	Distance from source			
		50 feet	100 feet	200 feet	400 feet
Heavy trucks	95	84-89	78-83	72-77	66-71
Dump trucks	108	88	82	76	70
Concrete mixer	105	85	79	73	67
Jackhammer	108	88	82	76	70
Scraper	93	80-89	74-82	68-77	60-71
Dozer	107	87-102	81-96	75-90	69-84
Generator	96	76	70	64	58
Crane	104	75-88	69-82	63-76	55-70
Loader	104	73-86	67-80	61-74	55-68
Grader	108	88-91	82-85	76-79	70-73
Dragline	105	85	79	73	67
Pile driver	105	95	89	83	77
Fork lift	100	95	89	83	77

a. Source: Golden et al. (1980).

400 feet from the construction sites, construction noises would range from approximately 60 to 80 dBA. Golden et al. (1980) suggest that noise levels higher than 80 to 85 dBA are sufficient to startle or frighten birds and small mammals. Thus, there would be minimal potential for disturbing birds and small mammals outside a 400-foot radius of the construction sites.

Although noise levels would be relatively low outside the immediate areas of construction, the combination of construction noise and human activity probably would displace small numbers of animals (e.g., songbirds and small mammals) that forage, feed, nest, rest, or den in the woodlands to the south and west of the F-Area Tank Farm and to the south of the H-Area Tank Farm. Construction-related disturbances are likely to create impacts to wildlife that would be small, intermittent, and localized. Some animals could be driven from the area permanently, while others could become accustomed to the increased noise and activity and return to the area. Species likely to be affected (e.g., gray squirrel, opossum, white-tailed deer) are common to ubiquitous in these areas.

Lay-down areas (approximately one to three acres in size) would be established in previously-disturbed areas immediately adjacent to the F- and H-Area Tank Farms to support construction activities under the Clean and Stabilize Tanks Alternative and the Clean and Remove Tanks Alternative. These lay-down areas would serve as staging and equipment storage areas. The specialized equipment required for handling and conveying fill material under the Clean and Stabilize Tanks Alternative (e.g., the batch plants and diesel generators) would also be placed in these lay-down areas. Creating these lay-down areas would have the effect of extending the zone of potential noise impact several hundred feet, but noise-related impacts would still be limited to a relatively small area (less than 20 acres) adjacent to the F- and H-Area Tank Farms.

As noted in Section 3.4.1, no threatened or endangered species, or critical habitat occurs in or near the F- and H-Area Tank Farms, which are heavy-industrial sites surrounded by roads, parking lots, construction shops, and construction laydown areas and are continually exposed to high levels of human disturbance. DOE will continue to monitor the tank farm area, and all of the SRS, for the presence of threatened or endangered species. If a listed species is found, DOE will determine if tank closure activities would affect that species. If DOE were to determine that adverse impacts may occur, DOE would initiate consultation with the U.S. Fish and Wildlife Service under Section 7 of the ESA.

DOE has not selected a location for the onsite borrow area, but suitability of a potential sites would be based on proximity to F- and H-Area, topography, characteristics of soil in an area, accessibility (whether or not access roads are present), and the presence/absence of sensitive resources such as wetlands and archaeological sites. DOE would attempt to locate a source of soil in a previously-developed area (or adjacent to a previously-developed area) in order to minimize disturbance to plant and animal communities. Representative impacts from borrow pit development would include the physical alteration of 7 to 14 acres of land (and attendant loss of potential wildlife habitat) and noise disturbances to nearby wildlife.

DOE would require approximately 51 acres of land in E-Area for use as low-activity waste storage vaults under the Clean and Remove Tanks Alternative. A total of 70 acres of developed land in E-Area was identified as available for waste management activities in the SRS Waste Management EIS. Currently only one low-activity waste storage vault has been constructed. The analysis in SRS Waste Management EIS found that the construction and operation of storage and disposal facilities within the previously cleared and graded portions of E-Area (i.e., developed) would have little effect on terrestrial wildlife. Wildlife habitat in these areas is poor and characterized by mowed grassy areas with few animals. Birds and mammals that use these areas, mostly for feeding, would be displaced by construction activities, but it is unlikely that they would be physically harmed or killed.

4.1.5 LAND USE

As can be see from Figures 3.5-1 and 3.5-2, the tank farms are in a highly industrialized portion of the SRS. Since bulk material removal would continue until completed, the transition of tanks to the HLW tank closure project would be phased over an approximately 30-year period. Consequently, closure activities would not result in short-term changes to the land use patterns of the SRS or alter the use or character of the tank farm areas.

As noted in Section 4.1.1, a substantial volume of soil (6 to 12.5 million cubic feet) could be required for backfill under the Clean and Stabilize Tanks Alternative or the Clean and Remove Tanks Alternative. DOE would obtain this soil from an onsite borrow area. Assuming an average depth of 20 feet for the borrow pit, the borrow area would be approximately 7 to 14 acres in surface area.

DOE has not selected a location for the onsite borrow area, but suitability of potential sites would be based on proximity to F- and H-Area, topography (ridges and hilltops would be avoided to limit erosion), characteristics of soil in an area, accessibility (whether or not access roads are present), and the presence/absence of sensitive resources such as wetlands and archaeological sites. DOE would attempt to locate a source of soil in a previously-developed area (or adjacent to a previously-developed area) in order to minimize the amount of undeveloped land converted to industrial use. Consistent with SRS long-term land use plans, any site selected would be within the central developed core of the SRS, which is dedicated to industrial facilities (DOE 1998). There would be no change in overall land use patterns on the SRS.

As discussed in Section 2.1.2, this amount of solid low-level waste generated under the Clean and Remove Tanks Alternative would require about 16 new low-activity waste vaults (650 feet by 150 feet). The land use impacts of constructing and operating the required low-activity-waste vaults were described and presented in the SRS Waste Management EIS (DOE/EIS-0217) and was based on constructing up to 31 low-activity waste vaults. Based on design information presented in the Waste Management EIS, the 16 vaults under the Clean and Remove Tanks Alternative would require just over 51 acres of land. In the SRS Waste Management EIS, DOE identified 70 acres of previously developed land in E-Area that is available for waste storage use. Since completion of the

SRS Waste Management EIS in July 1995, DOE has not identified the remaining land as a potential site for other activities therefore, there are no conflicting land uses and the analysis presented in the SRS Waste Management EIS is still valid. However, should future land uses change these changes would be made by DOE through the site development, land-use, and future-use planning processes, including public input through various avenues such as the Citizens Advisory Board. Finally any land use changes would be in accordance with the current Future Use Plan (DOE 1998).

4.1.6 SOCIOECONOMIC IMPACTS

Table 4.1.6-1 presents the estimated employment levels associated with each tank closure alternative.

For the No Action Alternative, operators, supervisors, technical staff and maintenance personnel would be required to monitor the tanks and maintain equipment and instruments. These activities are estimated to require about 40 personnel from the existing work force to cover shift and day operations (Johnson 1999).

As seen in Table 4.1.6-1, approximately 85 employees, on average, would be required to perform closure activities for the Clean and Fill with Grout and Sand Options under the Clean and Stabilize Tanks Alternative. The Clean and Fill with Saltstone Option would require approximately 130 employees (Caldwell 1999). The Clean and Remove Tanks Alternative would require, on average, over 280 employees. In each case, it is assumed two tanks will be closed per year. The employment estimates includes all employee classifications: operations, engineering, design, construction, support, and project management.

The maximum peak annual employment would occur under the Clean and Remove Tanks Alternative. This alternative would require less than 2 percent of the existing SRS workforce. All options under the Clean and Stabilize Tanks Alternative would require less than 1 percent of the existing SRS workforce.

Given the size of the economy in the six-county region of influence (described in Section 3.6), the estimated SRS workforce, and the size of the regional population and workforce, tank closure activities are not expected to result in any measurable socioeconomic impacts for any of the alternatives. Likewise, impacts to low-income or minority areas (as described in Section 3.6) are also not expected.

4.1.7 CULTURAL RESOURCES

As discussed in Chapter 2, activities associated with the tank closure alternatives at SRS would occur within the current F- and H-Area Tank Farms. Although there may have been prior human occupation at or near the F- and H-Area

Table 4.1.6-1. Estimated HLW tank closure employment.

		Clean and Stabilize Tanks Alternative			
	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	Clean and Remove Tanks Alternative
Annual employment (Full-time equivalent employees)[a,b]	40	85	85	131	284
Life of project employment (Full-time equivalent employees – years)[c]	980	2,078	2,078	3,210	6,963

a. Source: Caldwell (1999).
b. Assumes two tanks closed per year.
c. Total for all 49 tanks.

Tank Farms, the likelihood of historic resources surviving the construction of the tank farms in the early 1950s, before the enactment of regulations to protect such resources, would be small. The potential for the presence of prehistoric site in the candidate locations also is limited. As with any historic sites, tank farm construction activities probably destroyed or severely damaged prehistoric deposits. Therefore, tank closure activities would not be expected to further impact historic or prehistoric resources.

Under the Clean and Remove Tanks Alternative, 16 new low-activity waste vaults would be constructed in E-Area. As with the Tank Farm areas, previous DOE activities in E-Area probably destroyed or severely damaged any historic or prehistoric resources. Therefore, construction of these low-activity waste vaults would not be expected to further impact historic or prehistoric resources.

If any historic or archaeological resources should become threatened, however, DOE would take appropriate steps to identify the resources and contact the Savannah River Archaeological Research Program, the South Carolina Institute of Archaeology and Anthropology at the University of South Carolina and the State Historic Preservation Officer to comply with Section 106 of the National Historic Preservation Act.

4.1.8 WORKER AND PUBLIC HEALTH

This section discusses potential radiological and nonradiological health effects to SRS workers and the surrounding public from the HLW tank closure alternatives; it does not include impacts of potential accidents, which are discussed in Section 4.1.12. DOE based its calculations of health effects from the airborne radiological releases on (1) the dose to the hypothetical maximally exposed offsite individual; (2) the dose to the maximally exposed noninvolved worker (i.e., SRS employees who may work in the vicinity of the HLW tank closure facilities but are not directly involved in tank closure work); (3) the collective dose to the population within a 50-mile radius around the SRS (approximately 620,000 people); and (4) the collective dose to workers involved in implementing a given alternative (i.e., the workers involved in tank closure activities). All radiation doses mentioned in this EIS are effective dose equivalents; internal exposures are committed effective dose equivalents. This discussion characterizes health effects as additional lifetime latent cancer fatalities likely to occur in the general population around SRS and in the population of workers who would be associated with the alternatives.

Nonradiological health effects discussed in this section include health effects from nonradiological air emissions. In addition, occupational health impacts are presented in terms of estimated work-related illness and injury rates associated with each of the tank closure alternatives.

4.1.8.1 <u>Radiological Health Effects</u>

Radiation can cause a variety of health effects in people. The major effects that environmental and occupational radiation exposures could cause are delayed cancer fatalities, which are called latent cancer fatalities because the cancer can take many years to develop and cause death.

To relate a dose to its effect, DOE has adopted a dose-to-risk conversion factor of 0.0004 latent cancer fatality per person-rem for workers and 0.0005 latent cancer fatality per person-rem for the general population (NCRP 1993). The factor for the population is slightly higher due to the presence of infants and children who are believed to be more sensitive to radiation than the adult worker population.

DOE uses these conversion factors to estimate the effects of exposing a population to radiation. For example, in a population of 100,000 people exposed only to background radiation (0.3 rem per year), DOE would calculate 15 latent cancer fatalities per year caused by radiation (100,000 persons × 0.3 rem per year × 0.0005 latent cancer fatality per person-rem).

Calculations of the number of latent cancer fatalities associated with radiation exposure might not yield whole numbers and, especially in environmental applications, might yield values less than 1. For example, if a population of 100,000 were exposed to a dose of 0.001 rem per person, the collective dose would be 100 person-rem, and the corresponding number of latent cancer fatalities would be 0.05 (100,000 persons × 0.001 rem × 0.0005 latent cancer fatality per person-rem).

Vital statistics on mortality rates for 1997 (CDC 1998) indicate that the overall lifetime fatality rate in the United States from all forms of cancer is about 23.4 percent (23,400 fatal cancers per 100,000 deaths).

In addition to latent cancer fatalities, other health effects could result from environmental and occupational exposures to radiation; these include nonfatal cancers among the exposed population and genetic effects in subsequent generations. Previous studies have concluded that these effects are less probable than fatal cancers as consequences of radiation exposure (NCRP 1993). Dose-to-risk conversion factors for nonfatal cancers and hereditary genetic effects (0.0001 per person-rem and 0.00013 per person-rem, respectively) are substantially lower than those for fatal cancers. This EIS presents estimated effects of radiation only in terms of latent cancer fatalities because that is the major potential health effect from exposure to radiation. Estimates of nonfatal cancers and hereditary genetic effects can be estimated by multiplying the radiation doses by the appropriate dose-to-risk conversion factors for these effects.

DOE expects minimal worker and public health impacts from the radiological consequences of tank closure activities under any of the closure alternatives. All closure alternatives are expected to result in similar radiological release levels in the near-term. Public radiation doses would likely occur from airborne releases only (Section 4.1.3). Table 4.1.8-1 lists incremental radiation doses estimated for the noninvolved worker [a worker not directly involved with implementing the option but located 2,100 feet (a standard distance used for consistency with other SRS for NEPA evaluations) from the HLW tank farm] and the public (maximally exposed offsite individual and collective population dose) and corresponding incremental latent cancer fatalities, for each closure alternative. DOE based estimated worker doses on past HLW tank operating experience and the projected number of employees associated with each action (Newman 1999a; Johnson 1999). For the maximally exposed worker, DOE assumed that no worker would receive an annual dose greater than 500 millirem from any alternative because SRS uses the 500 millirem value as an administrative limit for normal operations: that is, an employee who receives an annual dose approaching the administrative limit normally is reassigned to duties in a nonradiation area. Table 4.1.8-2 estimates radiation doses for the collective population of workers who would be directly involved in implementing the options. This estimation was derived by assigning a specific number of workers for each tank closure task and then combining the tasks for each option/alternative. An average collective dose was then assigned for the closure of all 49 HLW tanks. Latent cancer fatalities likely attributable to the doses are also listed in this table. Individual worker doses were not calculated or assigned by this method. Total dose to the involved worker population was not evaluated by DOE due to the speculative nature of worker locations at the site. As expected, the Clean and Remove Tanks Alternative would result in larger radiological dose and health impacts due to larger manpower needs. However, impacts are well within the administrative control limit for SRS workers.

As shown in Table 4.1.8-2, post-closure activities would result in minimal radiological worker impacts. The Clean and Stabilize Tanks Alternative as well as the Clean and Remove Tanks Alternative would result in a smaller collective worker dose than the No Action Alternative. The lower dose is due to the reduced number of employees that would be needed once the tank closure activities are completed.

The estimated number of latent cancer fatalities in the public listed in Table 4.1.8-1 from airborne emissions for each alternative and/or options can be compared to the projected number of fatal cancers (143,863) in the public around the SRS from all causes (as discussed in Section 3.8.1). In all cases, the incremental impacts from the options would be small.

Table 4.1.8-1. Estimated radiological dose and health impacts to the public and noninvolved worker from SRS airborne emissions.

	F-Tank[a]					H-Tank[a]				
		Clean and Stabilize Tanks Alternative					Clean and Stabilize Tanks Alternative			
Receptor	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	Clean and Remove Tanks Alternative	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	Clean and Remove Tanks Alternative
Maximally exposed offsite individual dose (millirem/year)	2.5×10^{-5}	2.5×10^{-5}	2.5×10^{-5}	2.6×10^{-5}	2.5×10^{-5}	2.5×10^{-5}	2.5×10^{-5}	2.5×10^{-5}	2.6×10^{-5}	2.5×10^{-5}
Maximally exposed offsite individual dose over entire period of analysis (millirem)	6.1×10^{-4}	6.1×10^{-4}	6.1×10^{-4}	6.4×10^{-4}	6.1×10^{-4}	6.1×10^{-4}	6.1×10^{-4}	6.1×10^{-4}	6.4×10^{-4}	6.1×10^{-4}
Maximally exposed offsite individual estimated latent cancer fatality risk	3.1×10^{-10}	3.1×10^{-10}	3.1×10^{10}	3.2×10^{10}	3.1×10^{10}	3.1×10^{10}	3.1×10^{10}	3.1×10^{10}	3.2×10^{10}	3.1×10^{10}
Noninvolved worker dose (millirem/year)	2.6×10^{-3}	2.6×10^{-3}	2.6×10^{-3}	2.7×10^{-3}	2.6×10^{-3}	2.6×10^{-3}	2.6×10^{-3}	2.6×10^{-3}	2.7×10^{-3}	2.6×10^{-3}
Noninvolved worker individual dose over entire period of analysis (millirem)	6.4×10^{-2}	6.4×10^{-2}	6.4×10^{-2}	6.6×10^{-2}	6.4×10^{-2}	6.4×10^{-2}	6.4×10^{-2}	6.4×10^{-2}	6.6×10^{-2}	6.4×10^{-2}
Noninvolved worker estimated latent cancer fatality risk	2.5×10^{-8}	2.5×10^{-8}	2.5×10^{-8}	2.6×10^{-8}	2.5×10^{-8}	2.5×10^{-8}	2.5×10^{-8}	2.5×10^{-8}	2.6×10^{-8}	2.5×10^{-8}
Dose to population within 50 miles of SRS (person-rem/year)	1.4×10^{-3}	1.4×10^{-3}	1.4×10^{-3}	1.5×10^{-3}	1.4×10^{-3}	1.4×10^{-3}	1.4×10^{-3}	1.40×10^{-3}	1.5×10^{-3}	1.4×10^{-3}
Dose to population within 50 miles of SRS over entire period of analysis (person-rem)	3.4×10^{-2}	3.4×10^{-2}	3.4×10^{-2}	3.7×10^{-2}	3.4×10^{-2}	3.4×10^{-2}	3.4×10^{-2}	3.4×10^{-2}	3.7×10^{-2}	3.4×10^{-2}
Estimated increase in number of latent cancer fatalities in population within 50 miles of SRS	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	1.8×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	1.8×10^{-5}	1.7×10^{-5}

a. Estimated annual dose levels based on tank emissions in F-Area and H-Area.

Table 4.1.8-2. Estimated radiological dose and health impacts to involved workers by alternative.

	No Action Alternative[a]	Clean and Stabilize Tanks Alternative: Clean and Fill with Grout Option	Clean and Stabilize Tanks Alternative: Clean and Fill with Sand Option	Clean and Stabilize Tanks Alternative: Clean and Fill with Saltstone Option	Clean and Remove Tanks Alternative
Total workload per tank closure (person-year)[b]	NA	2.8	2.8	3.1	11.0
Collective involved worker dose (person-rem)[c]	29.4[d]	1,600	1,600	1,800	12,000
Estimated increase in number of latent cancer fatalities	0.012	0.65	0.65	0.72	4.9

NA = Not applicable.
a. For the No Action Alternative, a work level of 40 persons would be required per year for both tank farms. Source: Newman (1999a).
b. Source: Caldwell (1999).
c. Collective dose is for closure of all 49 tanks.
d. Collective dose for the No Action Alternative is for the period of closure activities for the other alternatives. This dose would continue indefinitely at a rate of approximately 1.2 person-rem per year.

4.1.8.2 Nonradiological Health Effects

DOE evaluated the range of chemicals to which the public and workers would be exposed due to HLW tank closure activities and expects minimal health impacts from nonradiological exposures. The onsite and offsite chemical concentrations from air emissions were discussed in Section 4.1.3. DOE estimated noninvolved worker impacts and site boundary concentrations to which a maximally exposed member of the public could be exposed.

OSHA limits (29 CFR Part 1910.1000) are time-weighted average concentrations that a facility cannot exceed in any 8-hour work shift of a 40-hour week. In addition, there are OSHA ceiling concentrations that may not be exceeded during any part of the workday. These exposure limits refer to airborne concentrations of substances and represent conditions under which nearly all workers could be exposed day after day without adverse health effects. However, because of the wide variation in individual susceptibility, a small percentage of workers could experience discomfort from concentrations of some substances at or below the permissible limit.

After analysis of expected activities during tank closure, DOE expects little possibility of involved workers in the tank farms and associated facilities being exposed to anything other than incidental concentrations of airborne nonradiological materials. Transfer of oxalic acid to and from the HLW tanks will be by sealed pipeline. Tank cleaning will be performed remotely. Normal industrial practices (e.g., wearing acid aprons and goggles) will be followed for all workers involved in acid handling. For routine operations, no exposure of personnel to oxalic acid would be expected. Therefore, health effects from exposure to nonradiological material inside the facilities or directly around the waste tanks would be small for all options.

The noninvolved worker concentrations were compared to OSHA permissible exposure limits or ceiling limits for protecting worker health, and DOE concluded that all pollutant concentrations were negligible compared to the OSHA standards except for oxides of nitrogen (NO_X).

The NO_X emissions result in ambient concentrations that are about 10 to 15 percent of the standard for all three options within the Clean and Stabilize Tanks Alternative.

Estimated pollutant releases for beryllium, benzene, and mercury are also expected to be within OSHA guidelines. The maximum excess lifetime cancer risk to the noninvolved worker from exposure to beryllium emissions was estimated to be 3.1×10^{-9}, based on the EPA's Integrated Risk Information System (IRIS) database unit risk factor for beryllium of 2.4×10^{-3} excess cancer risk per microgram per cubic meter. The maximum excess lifetime cancer risk to the noninvolved worker from benzene was estimated to be 8.3×10^{-9}, based on a unit risk factor for benzene of 8.3×10^{-6} excess cancer risk per microgram per cubic meter. These values are less than 1% of the 1.0×10^{-6} risk value that EPA typically uses as the threshold of concern. For mercury, there are inconclusive data relating to cancer studies. Therefore, EPA does not report unit risk factors for mercury. However, the mercury concentrations for the noninvolved worker and at the site boundary are less than 1% of their respective OSHA and SCDHEC standards respectively, for all options. The pollutant values are for the maximum option presented, which is Clean and Fill with Saltstone. All other options are expected to have lower impact values. See Table 4.1.3-4 for nonradiological pollutant concentrations discussed above.

Exposure to nonradiological contaminants such as beryllium and mercury could also result in adverse health effects other than cancer. For example, exposure to beryllium could result in the development of a scarring lung disease, chronic beryllium disease (also known as berylliosis). However, the beryllium and mercury concentrations at the noninvolved worker locations would be so low that adverse health effects would not be expected.

Likewise, site boundary concentrations were compared to the SCDHEC standards for ambient concentrations, and DOE concluded that all air emission concentrations were below the applicable standard. See Section 4.1.3 for comparison of estimated concentrations at the site boundary with SCDHEC standards.

4.1.8.3 Occupational Health and Safety

Table 4.1.8-3 provides estimates of the number of total recordable cases (TRCs) and lost workday cases (LWCs) that could occur during the entire tank closure process. The projected injury rates are based on historic SRS injury rates over a 5-year period from 1994 through 1998 multiplied by the employment levels for each alternative.

The TRC value includes work-related death, illness, or injury that resulted in loss of consciousness, restriction from work or motion, transfer to another job, or required medical treatment beyond first aid. The data for LWCs represent the number of workdays beyond the day of injury or onset of illness that the employee was away from work or limited to restricted work activity because of an occupational injury or illness.

The results that are presented in Table 4.1.8-3 show that the Clean and Remove Tanks Alternative has the highest number of total TRCs and LWCs (400 and 200, respectively because it would require the largest number of workers). The injury rate for the No Action Alternative is caused by the number of workers that are needed to continue to conduct operations if no action is taken in regard to tank closure activities.

4.1.8.4 Environmental Justice

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, directs each Federal agency to "make…achieving environmental justice part of its mission" and to identify and address "…disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations." The Presidential Memorandum that accompanied Executive Order 12898 emphasized the importance of using existing laws, including the National Environmental Policy Act, to identify and address environmental justice concerns, "including human health, economic, and social effects, of Federal actions."

The Council on Environmental Quality, which oversees the Federal government's compliance with Executive Order 12898 and the National Environmental Policy Act, subsequently developed guidelines to assist Federal agencies in incorporating the goals of Executive Order 12898

Table 4.1.8-3. Estimated Occupational Safety impacts to involved workers by alternative.

		Clean and Stabilize Tanks Alternative			
	No Action Alternative[a]	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	Clean and Remove Tanks Alternative
Total workload per tank closure (person-years)[b]	40	42	42	66	140
Total recordable cases of accident or injury[c]	110	120	120	190	400
Lost workday cases[c]	60	62	62	96	210

a. For the No Action Alternative, workload, TRC, and LWC estimates are for the period of closure activities for the other alternatives. These would continue indefinitely. Workload source: Johnson (1999).
b. Total manpower estimates are per tank. Source: Caldwell (1999).
c. TRC and LWC rates basis source: Newman (1999b).

in the NEPA process. This guidance, published in 1997, was intended to "…assist Federal agencies with their NEPA procedures so that environmental justice concerns are effectively identified and addressed."

As part of this process, DOE identified (in Section 3.6.2) minority and low-income populations within a 50-mile radius of the SRS (plus areas downstream of the Site that withdraw drinking water from the Savannah River), which was defined as the region of influence for the environmental justice analysis. The section that follows discusses whether implementing the alternatives described in Chapter 2 would result in disproportionately high or adverse impacts to minority and low-income populations.

Methodology

The Council Environmental Quality guidance (CEQ 1997) does not provide a standard approach or formula for identifying and addressing environmental justice issues. Instead, it offers Federal agencies general principles for conducting and environmental analysis under NEPA:

- Federal agencies should consider the population structure in the region of influence to determine whether minority populations, low-income populations, or Indian tribes are present, and if so, whether there may be disproportionately high and adverse human health or environmental effects on any of these groups.

- Federal agencies should consider relevant public health and industry data concerning the potential for multiple or cumulative exposure to human health or environmental hazards in the affected population and historical patterns of exposure to environmental hazards, to the extent such information is available.

- Federal agencies should recognize the interrelated cultural social, occupational, historical, or economic factors that may amplify the effects of the proposed agency action. These would include the physical sensitivity of the community or population to particular impacts.

- Federal agencies should develop effective public participation strategies that seek to overcome linguistic, cultural, institutional, and geographic barriers to meaningful participation, and should incorporate active outreach to affected groups.

- Federal agencies should assure meaningful community representation in the process, recognizing that diverse constituencies may be present.

- Federal agencies should seek tribal representation in the process in a manner that is consistent with the government-to-government relationship between the United States and trial governments, the Federal government's trust responsibility to Federally-recognized tribes, and any treaty rights.

First, DOE assessed the impacts of the proposed action and alternatives to the general population, which near the Savannah River Site includes minority and low-income populations. No special considerations, such as unique exposure pathways or cultural practices, contribute to any discernible disproportionate impacts. The only identified cultural practice (or unusual pathway) potentially associated with minority and low-income populations is use of the Savannah River for subsistence fishing. For the Draft and Final Accelerator Production of Tritium EIS (issued in 1999) DOE reviewed the limited body of literature available on subsistence activities in the region. DOE concluded that because the identified communities downstream from the SRS are widely distributed, and the potential impact to the general population is not discernible, there would be no potential for disproportionate impacts among minority or low-income populations. Second, having concluded that the potential off-site consequences to the general public of the proposed action and the alternatives would be small, DOE concluded there would be no disproportionately high and adverse impacts to minority or low-income populations.

The above stated conclusions are based on the comparison of HLW actions to past actions for which environmental justice issues were evaluated in detail. In 1995, DOE conducted an analysis of economic and racial characteristics of the population potentially affected by SRS operations within a 50-mile radius of the site Reference Interim Management EIS (DOE 1995). In addition, DOE examined the population downstream of the site that withdraws drinking water from the Savannah River. The economic and racial characterization was based on 1990 census tract data from the U.S. Census Bureau. More recent census tract data are not available. The nearest minority and low-income populations to SRS are to the south of Augusta, Georgia, northwest of the site.

This environmental justice analysis was based on the assessment of potential impacts associated with the various tank closure alternatives to determine if there would be high and adverse human health or environmental impacts. In this assessment, DOE reviewed potential impacts arising under the major disciplines and resource areas including socioeconomics, cultural resources, air resources, water resources, ecological resources, and public and worker health over the short term (approximately the years 2000 to 2030) and long term (approximately 10,000 years after HLW tanks are closed). Regarding health effects, both normal facility operations and postulated accident conditions were analyzed, with accident scenarios evaluated in terms of risk to workers and the public.

Although no high and adverse impacts were predicted for the activities analyzed in this EIS, DOE nevertheless considered whether there were any means for minority or low-income populations to experience disproportionately high and adverse impacts. The basis for making this determination would be a comparison of areas predicted to experience human health or environmental impacts with areas in the region of influence known to contain high percentages of minority or low-income populations.

The environmental justice analysis for the tank closure alternatives was assessed for a 50-mile area surrounding SRS (plus downstream areas) as discussed in Section 3.6.2.

<u>Short-Term Impacts</u>

For environmental justice concerns to be implicated, high and adverse human health or environmental impacts must disproportionately affect minority populations or low-income populations.

None of the proposed tank closure alternatives would produce significant short-term impacts to surface water (see Section 4.1.2.1) or groundwater (see Section 4.1.2.2). Emissions of nonradiological and radiological air pollutants from tank closure activities would be below regulatory limits (see Section 4.1.3) and would result in minimal impacts to workers (see Section 4.1.8.1) and the public (see Section 4.1.8.2). The estimated radiological doses and health impacts to the noninvolved worker and the public are very small (highest dose is 0.0026 millirem per year to the noninvolved worker, under the Saltstone Option of the Clean and Stabilize Tanks Alternative).

Because all tank closure activities would take place in an area that has been dedicated to industrial use for more than 40 years, no short-term impacts to ecological resources (see Section 4.1.4), existing land uses (see Section 4.1.5) or cultural resources (see Section 4.1.7) are expected.

Relatively small numbers of workers would be required to carry out tank closure activities regardless of the alternative selected (see Section 4.1.6); as a result, none of the tank closure alternatives would affect socioeconomic trends (i.e., unemployment, wages, housing) in the region of influence.

As noted in Section 4.2, no long-term environmental justice impacts are anticipated.

Because short-term impacts would not significantly impact the surrounding population, and no means were identified for minority or low-income populations to be disproportionately affected, no disproportionately high and adverse impacts would be expected for minority or low-income populations under any of the alternatives.

<u>Subsistence Consumption of Fish, Wildlife, and Game</u>

Section 4-4 of Executive Order 12898 directs Federal agencies "whenever practical and appropriate, to collect and analyze information on the consumption patterns of populations who principally rely on fish and/or wildlife for subsistence and that Federal governments communicate to the public the risks of these consumption patterns." There is no evidence to suggest that minority or low-income populations in the SRS region of influence are dependent on subsistence fishing, hunting, or gathering. DOE nevertheless considered whether there were any means for minority or low-income populations to be disproportionately affected by examining levels for contaminants in vegetables, fruit, livestock, and game animals collected from the SRS and from adjacent lands. In addition, DOE assessed concentrations of contaminants in fish collected from SRS waterbodies and from the Savannah River up- and downstream of the Site.

Based on recent monitoring results, concentrations of radiological and nonradiological contaminants in vegetables, fruit, livestock, game animals, and fish from the SRS and surrounding areas are generally low, in virtually all instances below applicable DOE standards (Arnett and Mamatey 1999). Consequently, no disproportionately high and adverse human health impacts would be expected in minority or low-income populations in the region that rely on subsistence consumption of fish, wildlife, or native plants.

It should be noted that mercury, which is present in relatively high concentrations in fish collected from SRS and the middle reaches of the Savannah River, could pose a potential threat to individuals and populations that rely on subsistence fishing. This mercury in fish has been attributed to upstream (non-DOE) industrial sources and natural sources (DOE 1997). The tank closure alternatives under consideration would not affect mercury concentrations in SRS waterbodies or the Savannah River.

4.1.9 TRANSPORTATION

SRS is served by more than 199 miles of primary roads and more than 995 miles of unpaved secondary roads. The primary highways used by SRS commuters are State Routes 19, 64, and 125; 40, 10, and 50 percent of the workers use these routes, respectively. Significant congestion can occur during peak traffic periods onsite on SRS Road 1-A, State Routes 19 and 125, and

U.S. Route 278 at SRS access points. Construction vehicles associated with this action would use these same routes and access points.

Cement (grout), saltstone, and sand are the different materials that could be used to fill the tanks. The trucks could come to the site with premixed fill material batched at the vendor's facility. If the Grout Option under the Clean and Stabilize Tanks Alternative were used, approximately 654 truckloads would be required to fill each waste tank, which would result in 654 round trips. The total trips for all 49 tanks would be 32,046. The Clean and Fill with Sand Option would require approximately 653 truckloads; therefore, 653 round trips would be necessary. The total trips for all 49 tanks would be 31,997. The Clean and Fill with Saltstone Option would result in approximately 19 truck loads and 19 round trips leading to 931 total trips for all the tanks. The No Action Alternative would not require any truckloads of material. Lastly, the Clean and Remove Tanks Alternative would require 5 truckloads of material, which would result in 5 round trips and 245 trips for all the tanks because only oxalic acid would be transported from offsite. See Table 4.1.9-1 for summary of data used to obtain the above information.

Assuming that the material is supplied by vendor facilities in Jackson and New Ellenton (i.e., a round-trip distance of 18 miles), closure of the tanks using each alternative would result in approximately 576,828 miles traveled for the grout fill option under the Clean and Stabilize Tanks Alternative, 575,946 miles for the sand fill option, 16,758 miles for the saltstone fill option, 0 miles for the No Action Alternative, and 4,410 miles for the Clean and Remove Tanks Alternative. Using Federal Aid Primary Highway System statistics for South Carolina for the 1986 to 1988 DOE calculated the impacts of potential transportation accidents for each alternative, which are presented in Table 4.1.9-2.

Regardless of the alternative chosen, it is anticipated that one tank would be closed at a time; therefore, the existing transportation structure would be adequate to accommodate this projected traffic volume. None of the routes associated with this transportation would require additional traffic controls and/or highway modifications. The surrounding area already has a certain volume of truck and car traffic associated with SRS logging, agriculture, and industrial activity. The amount of traffic associated with the proposed action would increase traffic volume by 0.025 percent based on traffic counts from the South Carolina Highway Department.

Table 4.1.9-1. Estimated maximum volumes of materials consumed and round trips per tank during tank closure.

		Clean and Stabilize Tanks Alternative			
Materials	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	Clean and Remove Tanks Alternative
Oxalic acid (4 weight percent) (gallons)	-	225,000	225,000	225,000	500,000
Soil (cubic meters)[a]	-	170,000	170,000	170,000	356,000
Sand (gallons)	-	-	2,640,000	-	-
Cement (gallons)	-	2,640,000	-	52,800	-
Fly ash (gallons)	-	-	-	Included in	-
Boiler slag (gallons)	-	-	-	saltstone	-
Additives (grout) (gallons)	-	500	-	-	-
Saltstone (gallons)	-	-	-	2,640,000	-
Round trips/tank	-	654	653	19	5

a. Soil values represent the total volume needed for the eight tanks requiring backfill under the Clean and Stabilize Tanks Alternative and the voids for all 49 tanks under the Clean and Remove Tanks Alternative.
- = not used in that option/alternative.

Table 4.1.9-2. Estimated transportation accidents, fatalities, and injuries during tank closure.

	No Action Alternative	Clean and Stabilize Tanks Alternative: Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	Clean and Remove Tanks Alternative
Accidents	NA	0.6	0.6	0.02	0.005
Fatalities	NA	0.08	0.08	0.002	0.0006
Injuries	NA	0.6	0.6	0.02	0.005

NA = Not applicable.

4.1.10 WASTE GENERATION AND DISPOSAL CAPACITY

This section describes impacts to the existing or planned SRS waste management systems resulting from closure of the HLW tank systems. Waste generation estimates are provided for each tank closure alternative that DOE considered in this EIS. Impacts are described in terms of increases in waste generation beyond that expected from other SRS activities during the same period and the potential requirements for new waste management facilities or expanded capacity at existing or planned facilities.

The SRS HLW tank systems include four tank designs (Types I, II, III, and IV). Estimates were developed for the volume of waste generated from closure of a single Type III tank system. Closure of a Type III tank system represents the maximum waste generation relative to the other tank designs. Waste generation estimates for closure of the other tank designs are assumed to be: Type I – 60 percent of Type III estimate, Type II – 80 percent of Type III estimates, and Type IV – 90 percent of Type III estimate. Table 4.1.10-1 provides estimates of the maximum annual waste generation. These annual values assume that two Type III tanks would be closed in one year. Table 4.1.10-2 provides the total waste volumes that would be generated from closure of the 49 remaining SRS HLW tank systems for each of the alternatives.

4.1.10.1 <u>Liquid Waste</u>

Radioactive liquid wastes would be generated as a result of tank cleaning activities under the Clean and Stabilize Tanks Alternative and Clean and Remove Tanks Alternative. The waste consists of the spent oxalic acid cleaning solutions and water rinses. This material would be managed as part of ongoing operations in the SRS HLW management system (e.g., evaporation and treatment of the evaporator overheads in the Effluent Treatment Facility). The projected volume of radioactive liquid waste under the Clean and Stabilize Tanks Alternative is 3.4 times the forecasted SRS HLW generation through 2029 (see Section 3.9, Table 3.9-1). The projected volume under the Clean and Remove Tanks Alternative is 6.9 times the forecasted SRS HLW generation for that period. This liquid waste would contain substantially less radioactivity than HLW and would not affect the environmental impacts of tank farm operations (i.e., there would be no increase in airborne emissions or worker radiation exposure).

DOE would need to evaluate the current schedule for closure of the HLW tank systems to ensure that adequate capacity remained in the Tank Farms to manage the amount of radioactive liquid waste generated from tank cleaning activities. A *High Level Waste System Plan* (WSRC 1998) has been developed to present the integrated operating strategy for the various components (Tank Farms, DWPF, salt disposition) comprising the HLW system. The *High Level Waste System Plan* integrates budgetary information, regulatory considerations (including waste removal and closure schedules), and production planning data (e.g., projected Tank Farm influents and effluents, evaporator operations, DWPF canister production). DOE uses computer simulations to model the operation of the HLW system. The amount of available Tank Farm storage space is an important parameter in those simulations. Other elements in the HLW

Table 4.1.10-1. Maximum annual generation for the HLW tank closure alternatives.[a]

		Clean and Stabilize Tanks Alternative			
	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	Clean and Remove Tanks Alternative
Radioactive liquid waste (gallons)	0	600,000	600,000	600,000	1,200,000
Nonradioactive liquid waste (gallons)	0	20,000	20,000	20,000	0
Transuranic waste (cubic meters)	0	0	0	0	0
Low-level waste (cubic meters)	0	60	60	60	900
Hazardous waste (cubic meters)	0	2	2	2	2
Mixed low-level waste (cubic meters)	0	12	12	12	20
Industrial waste (cubic meters)	0	20	20	20	20
Sanitary waste (cubic meters)	0	0	0	0	0

a. Source: Johnson (1999a,b).

Table 4.1.10-2. Total estimated waste generation for the HLW tank closure alternatives.[a]

		Clean and Stabilize Tanks Alternative			
	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	Clean and Remove Tanks Alternative
Radioactive liquid waste (gallons)	0	12,840,000	12,840,000	12,840,000	25,680,000
Nonradioactive liquid waste (gallons)	0	428,000	428,000	428,000	0
Transuranic waste (cubic meters)	0	0	0	0	0
Low-level waste (cubic meters)	0	1,284	1,284	1,284	19,260
Hazardous waste (cubic meters)	0	42.8	42.8	42.8	42.8
Mixed low-level waste (cubic meters)	0	257	257	257	428
Industrial waste (cubic meters)	0	428	428	428	428
Sanitary waste (cubic meters)	0	0	0	0	0

a. Source: Johnson (1999a,b).

system are adjusted to ensure the Tank Farms will have adequate waste storage capacity to support operations. The *High Level Waste System Plan* assumes that a salt disposition process will be operational by the year 2010. However, if the salt disposition process startup is delayed, the tank closure schedule may need to be extended because there would not be sufficient space in the tank farms to manage the large amounts of dilute liquid wastes generated by waste removal activities. The volume of this dilute waste can readily be reduced using the tank farm evaporators. The salt disposition process should be adequate to handle the additional radioactive liquid waste volume for the most water-intensive of the HLW tank closure alternatives (Clean and Remove Tanks) without schedule delays. The bulk of this wastewater would be generated at a time when other contributors to the tank farm inventory have stopped producing waste or dramatically reduced their generation rates. Delaying startup of the salt disposition process would result in about a year-for-year slip in the current waste removal schedule with a corresponding delay in tank closures. The need for any schedule modification would be identified through the *High Level Waste System Plan.*

Nonradioactive liquid wastes would be generated under the Clean and Stabilize Tanks Alternative as a result of flushing activities associated with the preparation and transport of all the fill material. This wastewater would be managed in existing SRS treatment facilities.

4.1.10.2 Transuranic Waste

DOE does not expect to generate transuranic wastes as a result of the proposed HLW tank system closure activities.

4.1.10.3 Low-Level Waste

Under the Clean and Stabilize Tanks Alternative and Clean and Remove Tanks Alternatives, approximately 30 cubic meters of solid low-level waste would be generated per Type III tank closure. This would consists of job control wastes (e.g., personnel protective equipment) generated from activities performed in the area of the tank top. Under the Clean and Remove Tanks Alternative, an additional 420 cubic meters of solid low-level waste would be generated as a result of each Type III tank removal. DOE assumed that any steel in direct contact with the waste would be removed (e.g., primary tank walls, cooling coils). The concrete shell and secondary containment liner would be left in place and the void space filled with soil. The steel components that are removed would be cut to a size that would fit into standard SRS low-level waste disposal boxes. The low-level waste would be disposed at existing SRS disposal facilities. The projected volume of low-level waste under the Clean and Stabilize Tanks Alternative is less than 1 percent of the forecasted SRS low-level waste generation through 2035. The projected volume under the Clean and Remove Tanks Alternative is about 11 percent of the forecasted SRS low-level waste generation for that period.

4.1.10.4 Hazardous Waste

Under the Clean and Stabilize Tanks Alternative and Clean and Remove Tanks Alternatives, a small amount (about 1 cubic meter) of nonradioactive lead waste would be generated from each Type III tank closure. The projected volume represents less than 1 percent of the forecasted SRS hazardous waste generation through 2035.

4.1.10.5 Mixed Low-Level Waste

Under the Clean and Stabilize Tanks Alternative, about 6 cubic meters of radioactive lead waste would be generated for each Type III tank closure. A slightly larger volume (10 cubic meters) would be generated from each Type III tank closure under the Clean and Remove Tanks Alternative. These projected volumes represent 7 and 12 percent, respectively, of the forecasted SRS mixed low-level waste generation through 2035.

4.1.10.6 Industrial Waste

DOE estimates that about 10 cubic meters of industrial (nonhazardous, nonradioactive) waste would be generated for each Type III tank closure under the Clean and Stabilize Tanks Alternative and Clean and Remove Tanks Alternatives.

4.1.10.7 Sanitary Waste

DOE does not expect to generate sanitary wastes as a result of the proposed HLW tank system closure activities.

4.1.11 UTILITIES AND ENERGY

This section describes the estimated utility and energy impacts associated with each of the HLW tank system closure alternatives that DOE considered in this EIS. Water, steam, and diesel fuel would be required to support many of the alternatives. Estimates of water use include preparation of cleaning solutions and rinsing of the tank systems. Steam is used primarily to operate the ventilation systems and to heat the cleaning solutions prior to use. Fuel consumption is based on use of diesel-powered equipment during tank closure activities. Total utility costs are also provided. The utility costs are primarily associated with fossil fuel consumption and steam generation. Water consumption is not a substantial contributor to the overall utility costs.

Table 4.1.11-1 lists the total estimated utility and energy requirements for each tank closure alternative. DOE used applicable past SRS operations or engineering judgements to estimate the utility consumption for new closure methods. The following paragraphs describe estimated utility requirements for the alternatives.

4.1.11.1 Water Use

Under the Clean and Stabilize Tanks Alternative, the estimated quantities of water are based on an assumption that three oxalic acid flushes (75,000 gallons each) and one water rinse (75,000 gallons) would be required to clean the tanks to the extent technically and economically feasible. Oxalic acid would be purchased in bulk and diluted with water to the desired strength (about 4 weight percent) prior to use in the tank farms. Under the Clean and Remove Tanks Alternative, DOE assumed that the quantities of cleaning solutions required to clean the HLW tank systems sufficiently to allow removal would be twice that required under the Clean and Stabilize Tanks Alternative. No water usage would be required under the No Action Alternative except for ballast water in those tanks that reside in the water table.

Additional water would be required for the Grout Option under the Clean and Stabilize Tanks Alternative. Water would be used to produce the reducing grout, controlled low-strength material (known as CLSM), and strong (high compressive strength) grout used to backfill the tank after cleaning is completed. Assuming a closure configuration of 5 percent reducing grout, 80 percent CLSM, and 15 percent strong grout, about 840,000 gallons of water would be required per Type III tank system (Johnson 1999c).

The largest annual water consumption, approximately 2.3 million gallons, would occur for closure of two Type III tanks in a given year. This volume represents less than 1 percent of current SRS groundwater production from industrial wells in the Tank Farms area (see Section 4.1.2.2).

Table 4.1.11-1. Total estimated utility and energy usage for the HLW tank closure alternatives.[a]

		Clean and Stabilize Tanks Alternative			
	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	Clean and Remove Tanks Alternative
Water (gallons)	7,120,000	48,930,000	12,840,000	12,840,000	25,680,000
Electricity	NA[b]	NA	NA	NA	NA
Steam (pounds)	NA	8,560,000	8,560,000	8,560,000	17,120,000
Fossil fuel (gallons)	NA	214,000	214,000	214,000	428,000
Total utility cost	NA	$4,280,000	$4,280,000	$4,280,000	$12,840,000

a. Source: Johnson (1999a,b,c,d).
b. NA = Not applicable to this alternative. Utility and energy usage for these alternatives would not differ significantly from baseline consumption.

4.1.11.2 Electricity Use

DOE assumed that there would be no significant additional electrical usage beyond that associated with current tank farm operations. This assumption is supported by DOE's closure of Tanks 17 and 20. Major power requirements associated with the HLW tank closure activities would be met by the use of diesel-powered equipment. Fuel consumption to power the equipment is addressed in Section 4.1.11.4.

4.1.11.3 Steam Use

The two main uses for steam are operation of the ventilation systems on the waste tanks during closure operations and heating of the cleaning solutions prior to use. Operation of the ventilation system uses about 100,000 pounds of 15 psig (pounds per square inch above atmospheric pressure) steam per year. The ventilation system operates as part of current tank farm operations. Thus, steam usage by the ventilation system was not included in this evaluation of tank closure alternatives.

Under the Clean and Stabilize Tanks Alternative, heating of the oxalic acid cleaning solution would use about 200,000 pounds of 150 psig steam per Type III tank system. The Clean and Remove Tanks Alternative would require twice as much oxalic acid cleaning solution and therefore would use twice (400,000 pounds per Type III tank system) as much steam as the Clean and Stabilize Tanks Alternative. There would be no additional steam requirements for the No Action Alternative (Johnson 1999c).

4.1.11.4 Diesel Fuel Use

Major power requirements would be covered by the use of diesel-powered equipment. Approximately 5,000 gallons of diesel fuel would be required for each Type III tank system closure under the Clean and Stabilize Tanks Alternative. The Clean and Remove Tanks Alternative would have twice the number of equipment operating hours as the Clean and Stabilize Tanks Alternative and would use 10,000 gallons of diesel fuel per Type III tank system closure. There would be no additional diesel fuel requirements for the No Action Alternative (Johnson 1999c,d).

4.1.12 ACCIDENT ANALYSIS

This section summarizes risks to the public and workers from potential accidents associated with the various alternatives for HLW tank closure at the SRS.

An accident is a sequence of one or more unplanned events with potential outcomes that endanger the health and safety of workers and the public. An accident can involve a combined release of energy and hazardous materials (radiological or chemical) that might cause prompt or latent health effects. The sequence usually begins with an initiating event, such as a human error, equipment failure, or earthquake, followed by a succession of other events that could be dependent or independent of the initial event, which dictate the accident's progression and the extent of materials released. Initiating events fall into three categories:

- *Internal initiators* normally originate in and around the facility but are always a result of facility operations. Examples include equipment or structural failures and human errors.

- *External initiators* are independent of facility operations and normally originate from outside the facility. Some external initiators affect the ability of the facility to maintain its confinement of hazardous materials because of potential structural damage. Examples include aircraft crashes, vehicle crashes, nearby explosions, and toxic chemical releases at nearby facilities that affect worker performance.

- *Natural phenomena initiators* are natural occurrences that are independent of facility operations and occurrences at nearby facilities or operations. Examples include earthquakes, high winds, floods, lightning, and snow. Although natural phenomena initiators are independent of external facilities, their occurrence can involve those facilities and compound the progression of the accident.

Table 4.1.12-1 summarizes the estimated impacts to workers and the public from potential accidents for each HLW tank closure alternative. Appendix B contains details of each accident, including the scenario description, probability, source term, and consequence. Table 4.1.12-1 lists potential accident consequences as latent cancer fatalities, without consideration of the accident's probability. Accidents involving nonradiological, hazardous materials were evaluated in Appendix B; however, these other accidents were shown to result in no significant impacts to the onsite or offsite receptors. Therefore, the accidents contained in Table 4.1.12-1 are limited to those involving the release of radiological materials.

DOE estimated impacts to three receptors: (1) a noninvolved worker 2,100 feet from the accident location, (2) the maximally exposed individual at the SRS boundary, and (3) the offsite population within 50 miles. DOE did not evaluate total dose to noninvolved worker population due the speculative nature of worker locations at the site.

DOE identified potential accidents in Yeung (1999) and estimated impacts using the AXAIRQ computer model (Simpkins 1995a,b), as discussed in Appendix B.

For all of the accidents, there is a potential for injury or death to involved workers in the vicinity of the accident. In some cases, the impacts to the involved worker would be greater than to the noninvolved worker. However, prediction of latent potential health effects becomes increasingly difficult to quantify as the distance between the accident location and the receptor decreases because the individual worker exposure cannot be precisely defined with respect to the presence of shielding and other protective features. The worker also may be acutely injured or killed by physical effects of the accident itself.

Table 4.1.12-1. Estimated accident consequences by alternative.

		Consequences					
Alternative	Accident frequency	Noninvolved worker (rem)	Latent cancer fatalities	Maximally exposed offsite individual (rem)	Latent cancer fatalities	Offsite population (person-rem)	Latent cancer fatalities
Clean and Stabilize Tanks Alternative							
Transfer errors during cleaning	Once in 1,000 years	7.3	2.9×10^{-3}	0.12	6.0×10^{-5}	5,500	2.8
Seismic event (DBE)[a] during cleaning	Once in 53,000 years	15	6.0×10^{-3}	0.24	1.2×10^{-4}	11,000	5.5
Failure of Salt Solution Hold Tank (Clean and Fill with Saltstone Option only)	Once in 20,000 years	0.02	8.0×10^{-6}	2.1	2.1×10^{-7}	17	8.4×10^{-3}
Clean and Remove Tanks Alternative							
Transfer errors during cleaning	Once in 1,000 years	7.3	2.9×10^{-3}	0.12	6.0×10^{-5}	5,500	2.8
Seismic event (DBE) during cleaning	Once in 53,000 years	15	6.0×10^{-3}	0.24	1.2×10^{-4}	11,000	5.5

a. DBE = Design basis earthquake.

4.2 Long-Term Impacts

Section 4.2 presents a discussion of impacts associated with residual radioactive and non-radioactive material remaining in the closed HLW tanks. DOE has estimated long-term impacts by completing a performance evaluation that includes fate and transport modeling over a long time span (10,000 years) to determine when certain measures of impacts (e.g., radiation dose) reach their peak value. More details on the methodology for long-term closure modeling analysis, and the uncertainties associated with this long-term modeling, are provided in Appendix C. The overall methodology for this long-term closure modeling is the same as the modeling used in the closure modules for Tanks 17 and 20 (DOE 1997a,b), which have been approved by SCDHEC and EPA Region IV. DOE intends to restrict the area around the tank farms from residential use for the entire 10,000-year period of analysis but has also assessed the potential impacts if institutional controls are lost and residents move into or intruders enter the tank farm areas.

Certain resources involve no long-term impacts and therefore are not included in the long-term analysis. These include air resources, socioeconomics, worker health, environmental justice, traffic and transportation, waste generation, and utilities and energy. Therefore, Section 4.2 presents impacts only for the following discipline areas: geologic resources, water resources, ecological resources, land use, and public health.

If the Clean and Remove Tanks Alternative were chosen, residual waste would be removed from the tanks and the tanks systems themselves would be removed and transported to SRS waste disposal facilities. Long-term impacts at these facilities are evaluated in the Savannah River Site Waste Management EIS (DOE/EIS-0217) (DOE 1995). The long-term impacts of low-level waste disposal in low-activity vaults presented in the SRS Waste Management EIS are approximately one-one thousandth of the long-term tank closure impacts presented in this EIS for water resources and public health and are incorporated into Section 4.2 of this EIS by reference.

4.2.1 GEOLOGIC RESOURCES

No geologic deposits within F- and H-Areas have been economically or industrially developed, and none are known to have significant potential for development. The Clean and Remove Tanks Alternative would result in backfilling the tank excavations. Because the backfill material would be locally derived from borrow pits at SRS (see Section 4.1.1), it is assumed to be similar to the natural soils and sediments encountered in the excavations; therefore, no long-term impacts to geologic deposits would occur.

The other tank closure alternatives include closing the tanks in place, which would result in residual waste remaining in the tanks. Upon failure of the tanks as determined by each of the alternatives described in Appendix C, the waste in the tanks would have the potential to contaminate the surrounding soils. The inventory and concentration of the residual waste is expected to be less than that listed in Appendix C, Tables C.3.1-1 and C.3.1-2, which are based on conservative assumptions for the waste that would remain in the tanks after waste removal and washing. The residual waste has the potential to contaminate percolating groundwater at some point in the future due to leaching. The water-borne transport of contaminants would contaminate geologic deposits that lie below the tanks. The contamination would not result in any significant physical alteration of the geologic deposits. Filling the closed-in-place tanks with ballast water, sand, saltstone, or grout may also increase the infiltration of precipitation at some point in the future, allowing a greater percolation of water into the underlying geologic deposits. No detrimental effect on surface soils, topography, or to the structural or load-bearing properties of geologic deposits would occur from these actions. There are no anticipated long-term impacts to geologic resources from the Clean and Remove Tanks Alternative. The No Action Alternative and all options under the Clean and Stabilize Tanks Alternative would allow the soils in the vicinity of the tanks to be impacted.

4.2.2 WATER RESOURCES

4.2.2.1 Surface Water

Because the No Action Alternative and Clean and Stabilize Tanks Alternative would leave some residual radioactive and non-radioactive material in waste tanks, the potential would exist for long-term impacts to groundwater. Contaminants in groundwater could then be transported through the Water Table, Barnwell-McBean, or Congaree Aquifers to the seeplines along Fourmile Branch and Upper Three Runs, respectively (see Section 4.2.2.2 for a more detailed discussion). The factors governing the movement of contaminants through groundwater (i.e., the hydraulic conductivity, hydraulic gradient, and effective porosity of aquifers in the area) and the processes resulting in attenuation of radiological and non-radiological contaminants (i.e., radioactive decay, ion exchange in the soil, and adsorption to soil particles) would be expected to mitigate subsequent impacts to surface water resources.

DOE used the Multimedia Environmental Pollution Assessment System (MEPAS) computer code (Buck et at. 1995) to model the fate and transport of contaminants in groundwater and subsequent flux to surface waters. Maximum annual concentrations of contaminants at various locations) were estimated and compared to appropriate water quality criteria for the protection of aquatic life.

EPA periodically publishes water quality criteria, which are concentrations of substances that are known to affect "diversity, productivity, and stability" of aquatic communities including "plankton, fish, shellfish, and wildlife" (EPA 1986, 1999). These recommended criteria provide guidance for state regulatory agencies in the development of location-specific water quality standards to protect aquatic life (SCDHEC 1999). Such standards are used in implementing a number of environmental programs, including setting discharge limits in NPDES permits. Water quality criteria and standards are generally not legally enforceable; however, NPDES discharge limits based on these criteria and standards are legally binding and are enforced by SCDHEC.

The results of the fate and transport modeling of non-radiological contaminants are presented in Tables 4.2.2-1 (Upper Three Runs) and 4.2.2-2 (Fourmile Branch). Based on the modeling, any of the three tank stabilization options under the Clean and Stabilize Tanks Alternative would be effective in limiting the movement of residual contaminants in closed tanks to nearby streams via groundwater. Concentrations of non-radiological contaminants moving to Upper Three Runs via the Upper Three Runs seepline would be minuscule, in all cases several times lower than applicable standards. Concentrations of non-radiological contaminants reaching Fourmile Branch via the Fourmile Branch seepline would also be low under the Clean and Stabilize Tanks Alternative. Concentrations of contaminants reaching Upper Three Runs and Fourmile Branch would be low under the No Action Alternative as well, but somewhat higher than those expected under the Clean and Stabilize Tanks Alternative. In all instances, predicted concentrations of non-radiological contaminants were well below applicable water quality standards.

Based on the modeling results, all three stabilization options under the Clean and Stabilize Tanks Alternative would be more effective than the No Action Alternative. The Clean and Fill with Grout Option would be most effective of the three tank stabilization options under the Clean and Stabilize Tanks Alternative for reducing contaminant migration to surface water.

Table 4.2.2-3 shows maximum radiation doses to humans in surface (drinking) water at the points of compliance for Upper Three Runs and Fourmile Branch. Doses are low under all three tank stabilization options, and are well below the drinking water standard of 4 millirem per year (40 CFR 141.16). The 4 millirem per year standard applies only to beta- and gamma-emitting radionuclides, but since the total dose is less than 4 millirem per year, then the standard is met. The DOE dose limit for native aquatic animals is 1 rad per day from exposure to radio-

Table 4.2.2-1. Maximum concentrations of non-radiological constituents of concern in Upper Three Runs (milligrams/liter).

	Clean and Stabilize Tanks Alternative					
	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Water Quality Criteria[a] Acute	Water Quality Criteria[a] Chronic
Aluminum	(b)	(b)	(b)	(b)	0.750	0.087
Chromium IV	(b)	(b)	(b)	(b)	0.016	0.011
Copper	(b)	(b)	(b)	(b)	0.0092	0.0065
Iron	(b)	(b)	(b)	3.7×10^{-5}	2.000	1.000
Lead	(b)	(b)	(b)	(b)	0.034	0.0013
Mercury	(b)	(b)	(b)	(b)	0.0024	1.2×10^{-5}
Nickel	(b)	(b)	(b)	(b)	0.790	0.088
Silver	(b)	(b)	(b)	1.2×10^{-6}	0.0012	-----

a. Criteria to Protect Aquatic Life (SCR. 61-68, Appendix 1).
b. Concentration less than 1.0×10^{-6} milligrams/liter.

Table 4.2.2-2. Maximum concentrations of non-radiological constituents of concern in Fourmile Branch (milligram/liter).

	Clean and Stabilize Tanks Alternative					
	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Water Quality Criteria[a] Acute	Water Quality Criteria[a] Chronic
Aluminum	(b)	(b)	(b)	(b)	0.750	0.087
Chromium IV	(b)	(b)	(b)	(b)	0.016	0.011
Copper	(b)	(b)	(b)	(b)	0.0092	0.0065
Iron	3.0×10^{-5}	3.0×10^{-5}	3.0×10^{-5}	4.9×10^{-4}	2.000	1.000
Lead	(b)	(b)	(b)	(b)	0.034	0.0013
Mercury	(b)	(b)	(b)	(b)	0.0024	1.2×10^{-5}
Nickel	(b)	(b)	(b)	(b)	0.790	0.088
Silver	8.8×10^{-6}	6.5×10^{-6}	8.8×10^{-6}	1.1×10^{-4}	0.0012	-----

a. Criteria to Protect Aquatic Life (SC R. 61-68, Appendix 1).
b. Concentration less than 1.0×10^{-6} milligram/liter.

Table 4.2.2-3. Maximum drinking water dose from radionuclides in surface water (millirem/year).

	Clean and Stabilize Tanks Alternative			
	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
Upper Three Runs	(a)	4.3×10^{-3}	9.6×10^{-3}	0.45
Fourmile Branch	9.8×10^{-3}	0.019	0.130	2.3

Radiation dose for this alternative is less than 1×10^{-3} millirem.

active materials in liquid wastes discharged to natural waterways (DOE Order 5400.5). The absorbed dose (see Table 4.2.3-3) from surface water would be a small fraction of the DOE dose limit under any of the alternatives, including No Action.

4.2.2.2 Groundwater

Contamination Source

Waste remaining in tanks as a result of the closure alternatives has been identified as the primary source for long-term impacts to groundwater quality. The physical configurations of the waste after closure and the chemical parameters associated with the resulting contamination source zone would, however, vary between the closure alternatives. The in-place closure alternatives consist of the following:

- No Action Alternative (bulk waste removal and fill with ballast water)
- Clean and Stabilize Tanks Alternative
  - Clean and Fill with Grout Option (Preferred Alternative)
  - Clean and Fill with Sand Option
  - Clean and Fill with Saltstone Option

For the No Action Alternative, the contaminant inventory would be the highest because this alternative would not provide for tank cleaning following bulk waste removal. In addition, filling the tanks with ballast water would allow for the immediate generation of a large volume of contaminated leachate. For the three tank stabilization options under the Clean and Stabilize Tanks Alternative, cleaning of the tanks would result in lower initial volume and inventory of contaminants in the residual waste prior to filling. The Clean and Fill with Grout Option would produce a source zone that consists of the residual waste covered by a low-permeability reducing grout. The grout fill would lower the water infiltration until failure and would reduce the leach rate of chemicals compared to the other options. The source zone for this option, therefore, would have more time to undergo radioactive decay prior to tank failure compared to the other alternatives. The Clean and Fill with Sand Option would result in little physical alteration of the residual waste in the tanks other than some mixing and an overall increase in the volume of contaminated material. This option also would result in a higher leaching rate than the Clean and Fill with Grout or Saltstone Options. The Clean and Fill with Saltstone Option would bind the residual waste and create a low-permeability zone compared to natural soils; however, the overall magnitude of the source term would be increased due to the presence of background contamination in the saltstone medium.

The evaluation and comparison of the in-place closure alternatives uses the results of long-term groundwater fate and transport modeling to interpret the potential impacts to groundwater resources beneath the F- and H-Area Tank Farms for each of the alternatives. Areas within the groundwater migration pathway to the downgradient point of compliance (the seepline along Upper Three Runs and Fourmile Branch, located approximately 1,200 meters downgradient of F-Area Tank Farm and approximately 1,800 meters downgradient of H-Area Tank Farm) are also included in the evaluation. The analysis also presents the impacts to groundwater at 1 meter and 100 meters downgradient of the tank farm. Impacts are presented in tables in the following sections that compare the predicted (i.e., modeled) groundwater concentrations to regulatory limits or established SRS guidelines for the various contaminants of interest.

The tank farms were modeled assuming conditions that would exist after tank closure for each of the alternatives that included closure of the tanks in place. The identity and level of residual contaminants in each tank were derived from data provided by Johnson (1999).

Each of the closure alternatives proposed in Chapter 2 except for tank removal includes actions that may result in potential long-term impacts to groundwater beneath the tank farms. Because groundwater is in a state of constant flux, impacts that occur directly above or below the tank farms may propagate to areas hydraulically downgradient of the tank farms. The primary action that would result in long-term impacts to groundwater is in-place tank closure that would result in some quantity of residual waste material remaining in the tanks. The residual waste has the potential to contaminate groundwater at some point in the future due to leaching and water-borne transport of contaminants.

The tank farms are situated in highly developed industrial areas. Some of the tank groups were constructed in pits substantially lower in elevation than the surrounding terrain. The existing tank farm sites, therefore, include facilities and structures designed to prevent surface ponding and to manage precipitation runoff in a controlled manner. Reclamation of the tank farms after closure would require backfilling and grading to provide a suitable site for future industrial/commercial development, to prevent future ponding of water at the surface, and to promote non-erosional surface water runoff. Backfilling and grading would be performed using borrow material derived from local areas at the SRS (see Section 4.1.1). The material is assumed to be physically similar to the in-place materials. Therefore, there should be little or no impact to long-term groundwater recharge or quality as a result of the surface reclamation activities. Because the tanks would be completely removed from service at closure, there are no other long-term operations at the tank farms that could potentially impact groundwater resources.

Modeling Methodology

The modeling results are used to predict whether each closure alternative and option would meet the identified regulatory and SRS water quality criteria at the point of compliance. This process addresses the cumulative effect of all the tanks in a tank farm whose plumes may intersect. Because of the physical separation of the F- and H-Area Tank Farms and the hydrogeologic setting, no overlapping of plumes from the two tank farms is anticipated. The presence of a groundwater divide that runs through the H-Area Tank Farm required a separation of the tank groups in the H-Area. This separation was necessary to identify impacts at various locations that are separated in both space and time as a result of the various groundwater flow directions and paths that leave different areas of the H-Area Tank Farm. Therefore the analysis and presentation of results are provided on a tank-farm or tank-grouping basis for each alternative.

Modeling the fate and transport of contaminants was performed using the Multimedia Environmental Pollutant Assessment System (MEPAS) computer model (Buck et al. 1995). The program is EPA-recognized and uses analytical methods to model the transport of contaminants from a source unit to any point at which the user desires to calculate the concentration. The modeling effort requires certain assumptions about the contaminant source term, source configuration, and hydrogeologic structure of the area between each of the tank farms, or tank groups, and the point where impacts are evaluated. Appendix C presents the major assumptions and inputs used in modeling concentrations of contaminants.

To account for overlapping of the contaminant plumes from separate tank groups that discharge to the same location, the modeled groundwater concentrations were summed as if the various tank groups were at the same initial physical location. Because of the size of the tank groups and the length of the groundwater flow paths, sensitivity analyses showed that the actual location of the contaminant source within the tank group had little impact at the point of analysis at the seepline. The impact analysis also summed the centerline concentrations from each tank-group plume at the point of analysis to ensure that the highest concentration was reported. Therefore, although the plumes from different tank groups may not overlap entirely, the calculation methodology provides an upper estimate for the predicted groundwater impacts. The simplification of treating all the tanks in a group as if they are at the same physical location has the effect of greatly exaggerating estimated groundwater concentrations and doses at close-in locations, including 1-meter and 100-meter wells.

For all of the tank groups in F-Area and for several groups in H-Area, the historical water level data showed that the tank bottoms are elevated above the zone of groundwater saturation. For these tanks, the modeling simulated leaching of contaminants from the waste zone and vertical migration to the water table. It was observed that some tank groups in the H-Area tank farm, due to their installation depth and the presence of a local high in the water table, lie partially or nearly entirely in the zone of groundwater saturation. The modeling simulation was adjusted for these sites to account for submergence of the contamination source zone.

Groundwater Quality Impacts

As described in detail in Appendix C, groundwater flowing beneath the tank farms flows in different directions and includes vertical flow components. In the analyzed alternatives, the mobile contaminants in the tanks would gradually migrate downward through unsaturated soil to the hydrogeologic units comprising the shallow aquifers underlying the tank farms. As identified above, because some tank groups in the H-Area lie beneath the water table, the contaminants from these tanks would be released directly into the groundwater.

The first hydrogeologic unit impacted would be the Water Table Aquifer formally known as the upper zone of the Upper Three Runs Aquifer (Aadland et al. 1995). Some contaminants from each tank farm would be transported by groundwater through the Water Table Aquifer to the seepline along Fourmile Branch. For tanks situated north of the groundwater divide in the H-Area Tank Farm, contaminants released to the Water Table Aquifer may discharge to unnamed tributaries of Upper Three Runs or migrate downward to underlying aquifers. Previous DOE modeling results for this portion of H-Area, (GeoTrans 1993), from which the model inputs were based, showed that approximately 73 percent of the contaminant mass released from these tanks would remain in the Water Table and Barnwell-McBean Aquifers and 27 percent would migrate to the Congaree Aquifer (i.e., Gordon Aquifer) to a point of discharge along Upper Three Runs.

For tank groups located in the F-Area and for tank groups located south of the groundwater divide in H-Area, the contaminant mass released was simulated to migrate both laterally and vertically based on the hydrogeologic setting. Previous DOE modeling results for F-Area (GeoTrans 1993), from which the model inputs were derived, showed that approximately 96 percent of the contaminant mass released from the F-Area tanks would remain in the Water Table and Barnwell-McBean Aquifers and would discharge at the seepline along lower Fourmile Branch. Previous DOE modeling results for H-Area (GeoTrans 1993) showed that approximately 78 percent of the released contaminant mass would remain in the Water Table and Barnwell-McBean Aquifers and would discharge at the seepline along upper Fourmile Branch. The remaining 22 percent of contaminant mass released from the H-Area tanks was simulated as migrating downward and laterally through the Congaree Aquifer to a point of discharge at the seepline along Upper Three Runs.

Summary of Estimated Concentrations

The results of the groundwater fate and transport modeling for radiological and non-radiological contaminants for each tank farm are presented in Tables 4.2.2-4 through 4.2.2-8. The modeling calculated impacts for each aquifer layer. Because the concentrations in groundwater from the various aquifers are not additive, only the maximum value is presented in the tables. The results are presented for each alternative for the 1-meter and 100-meter wells, and for the seepline. Figure 4.2.2-1 illustrates some of the same results graphically. This figure shows the predicted concentrations over time at the Three Runs seepline (north of the groundwater divide) resulting from contamination transported from the H-Area Tank Farm through the Water Table and Barnwell-McBean Aquifers. Results at the other modeled exposure locations show similar patterns over time. The pattern of the peaks in the graph results from the simplified and conservative approach used in modeling, such as the simplifying assumption that the tanks would release their entire inventories simultaneously and completely. The specific concentrations for each radiological and nonradiological contami-

Table 4.2.2-4. Maximum radiological groundwater concentrations from contaminant transport from F-Area Tank Farm.[a]

Radiological emitter - exposure point	No Action Alternative	Clean and Stabilize Tanks Alternative: Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option
Drinking water dose (millirem/yr)				
1-meter well	35,000	130	420	790
100-meter well	14,000	51	190	510
Seepline	430	1.9	3.5	25
Maximum Contaminant Level (millirem/yr)	4	4	4	4
Alpha concentration (picocuries per liter)				
1-meter well	1,700	13	13	13
100-meter well	530	4.8	4.7	4.8
Seepline	9.2	0.04	0.039	0.04
Maximum Contaminant Level (pCi/liter)	15	15	15	15

a. The Clean and Remove Tanks Alternative is not presented in this table because the residual waste (and tank components) would be removed from the Tank Farm areas and transported to SRS radioactive waste disposal facilities. The environmental impacts of these disposal facilities were analyzed in the SRS Waste Management EIS (DOE 1995).

Table 4.2.2-5. Maximum radiological groundwater concentrations from contaminant transport from H-Area Tank Farm.[a]

Radiological emitter - exposure point	No Action Alternative	Clean and Stabilize Tanks Alternative: Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option
Drinking water dose (millirem/yr)				
1-meter well	9.3×10^{6}	1×10^{5}	1.3×10^{5}	1×10^{5}
100-meter well	9.0×10^{4}	300	920	870
Seepline, North of Groundwater Divide	2,500	2.5	25	46
Seepline, South of Groundwater Divide	200	0.95	1.4	16
Maximum Contaminant Level (millirem/yr)	4	4	4	4
Alpha Concentration (picocuries per liter)				
1-meter well	13,000	24	290	24
100-meter well	3,800	7.0	38	7.0
Seepline, North of Groundwater Divide	34	0.15	0.33	0.15
Seepline, South of Groundwater Divide	4.9	0.02	0.019	0.02
Maximum Contaminant Level (pCi/liter)	15	15	15	15

a. The Clean and Remove Tanks Alternative is not presented in this table because the residual waste (and tank components) would be removed from the Tank Farm areas and transported to SRS radioactive waste disposal facilities. The environmental impacts of these disposal facilities were analyzed in the SRS Management EIS (DOE 1995).

Table 4.2.2-6. Maximum nonradiological groundwater concentrations from contaminant transport from F- and H-Area Tank Farm, 1-meter well.[a]

	Maximum concentration (percent of MCL)				
	Barium	Fluoride	Chromium	Mercury	Nitrate
No Action Alternative					
Water Table	0.0	18.5	320	6,500	150
Barnwell McBean	0.0	47.5	380	0.0	270
Congaree	0.0	6.8	0.0	0.0	62
Clean and Fill with Grout Option					
Water Table	0.0	0.3	21	70	2.3
Barnwell McBean	0.0	5	23	0.0	21
Congaree	0.0	0.1	0.0	0.0	0.5
Clean and Fill with Sand Option					
Water Table	0.0	1.6	8.5	37	6.7
Barnwell McBean	0.0	5.3	19	0.0	22
Congaree	0.0	0.1	0.0	0.0	0.7
Clean and Fill with Saltstone Option					
Water Table	0.0	0.3	21	70	240,000
Barnwell McBean	0.0	5	23	0.0	440,000
Congaree	0.0	0.1	0.0	0.0	160,000

Notes: MCL = Maximum Contaminant Level. Only those contaminants with current EPA Primary Drinking Water MCLs are included in table. A value of "100" for a given contaminant is equivalent to the MCL concentration.

a. The Clean and Remove Tanks Alternative is not presented in this table because the residual waste (and tank components) would be removed from the Tank Farm areas and transported to SRS radioactive waste disposal facilities. The environmental impacts of these disposal facilities were analyzed in the SRS Waste Management EIS (DOE 1995).

Table 4.2.2-7. Maximum nonradiological groundwater concentrations from contaminant transport from F- and H-Area Tank Farm, 100-meter well.[a]

	Maximum concentration (percent of MCL)				
100-Meter well	Barium	Fluoride	Chromium	Mercury	Nitrate
No Action Alternative					
Water Table	0.0	8.3	74	265	69
Barnwell McBean	0.0	12.5	81	0.0	58
Congaree	0.0	1.2	0.0	0.0	11
Clean and Fill with Grout Option					
Water Table	0.0	0.1	2.7	1.5	0.7
Barnwell McBean	0.0	1.1	4.4	0.0	4.7
Congaree	0.0	0.0	0.0	0.0	0.1
Clean and Fill with Sand Option					
Water Table	0.0	0.3	1.5	2.7	1.3
Barnwell McBean	0.0	1.2	3.7	0.0	4.9
Congaree	0.0	0.0	0.0	0.0	0.1
Clean and Fill with Saltstone Option					
Water Table	0.0	0.1	2.7	1.5	68,000
Barnwell McBean	0.0	1.1	4.4	0.0	180,000
Congaree	0.0	0.0	0.0	0.0	21,000

Notes: MCL = Maximum Contaminant Level. Only those contaminants with current EPA Primary Drinking Water MCLs are included in table. A value of "100" for a given contaminant is equivalent to the MCL concentration.

a. The Clean and Remove Tanks Alternative is not presented in this table because the residual waste (and tank components) would be removed from the Tank Farm areas and transported to SRS radioactive waste disposal facilities. The environmental impacts of these disposal facilities were analyzed in the SRS Waste Management EIS (DOE 1995).

Table 4.2.2-8. Maximum nonradiological groundwater concentrations from contaminant transport from F- and H-Area Tank Farm, seepline.[a]

Fourmile Branch seepline	Maximum concentration (percent of MCL)				
	Barium	Fluoride	Chromium	Mercury	Nitrate
No Action Alternative					
Water Table	0.0	0.4	1.0	0.0	3.4
Barnwell McBean	0.0	0.5	0.8	0.0	2.4
Congaree	0.0	0.0	0.0	0.0	0.1
Clean and Fill with Grout Option					
Water Table	0.0	0.0	0.0	0.0	0.0
Barnwell McBean	0.0	0.0	0.0	0.0	0.1
Congaree	0.0	0.0	0.0	0.0	0.0
Clean and Fill with Sand Option					
Water Table	0.0	0.0	0.0	0.0	0.1
Barnwell McBean	0.0	0.0	0.0	0.0	0.2
Congaree	0.0	0.0	0.0	0.0	0.0
Clean and Fill with Saltstone Option					
Water Table	0.0	0.0	0.0	0.0	3,000
Barnwell McBean	0.0	0.0	0.0	0.0	3,300
Congaree	0.0	0.0	0.0	0.0	300

Notes: Only those contaminants with current EPA Primary Drinking Water MCLs are included in table. A value of "100" for a given contaminant is equivalent to the MCL concentration.

a. The Clean and Remove Tanks Alternative is not presented in this table because the residual waste (and tank components) would be removed from the Tank Farm areas and transported to SRS radioactive waste disposal facilities. The environmental impacts of these disposal facilities were analyzed in the SRS Waste Management EIS (DOE 1995).

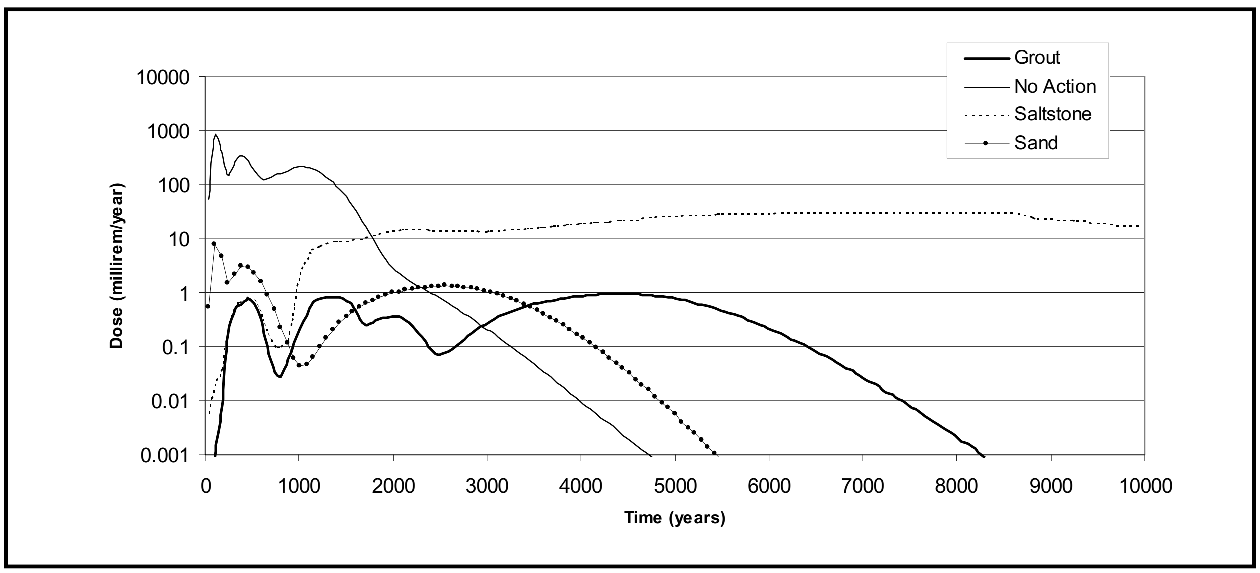

Figure 4.2.2-1 Predicted Drinking Water Dose Over Time at the H-Area Seepline North of the Groundwater Divide in the Barnwell-McBean and Water Table Aquifers.

nant for each aquifer layer and each exposure point are presented in Appendix C. For radiological contaminants, the dose in millirem per year from all radionuclides or the concentration of all alpha-emitting radionuclides are considered additive for any given aquifer layer at any exposure point. The maximum radiation dose (millirem per year) and maximum alpha concentration (picocuries per liter) regardless of the aquifer layer, therefore, are presented in the tables for each exposure point. This data represents the increment in time when the sum of all beta-gamma or alpha emitters is greatest but not necessarily when each species is at its maximum concentration. This method of data presentation shows the overall maximum dose or concentration that occurs at each exposure point.

For nonradiological contaminants the effects of the contaminants are not considered to be additive. The maximum concentration of each nonradiological contaminant, regardless of time, was determined for each aquifer layer and for each exposure point. Only those contaminants with current EPA Drinking Water Standard Maximum Contaminant Levels are shown on the tables. For comparison between the different alternatives the maximum value for each nonradiological contaminant was converted to its percentage of the Maximum Contaminant Level. This value provides a streamlined, quantitative method of comparing the impacts of the maximum concentrations for each alternative.

Comparison of Alternatives

The radiological results provided in Tables 4.2.2-4 through 4.2.2-5 and illustrated in Figure 4.2.2-1 consistently show that the greatest long-term impacts occur under the No Action Alternative. For this alternative, the Maximum Contaminant Level for beta-gamma radionuclides is exceeded at all points of exposure. On the other hand, the Clean and Fill with Grout Option shows the lowest-long term impacts at all exposure points, and the Maximum Contaminant Level for beta-gamma radionuclides is met at the seepline for this alternative. Also, Figure 4.2.2-1 shows that impacts would occur later than under the No-Action Alternative or the Clean and Fill with Sand Option. Peak dose under the Clean and Fill with Sand Alternative would be less than under the No-Action Alternative and the Maximum Contaminant Level would be met at the seepline, but doses would be greater than under the Clean and Fill with Grout Option and would occur sooner. Like the Clean and Fill with Sand Option, the Clean and Fill with Saltstone Option would delay the impacts at the seepline, but it would result in a higher peak dose than either the Clean and Fill with Grout or Clean and Fill with Sand Options (the peak dose under this alternative would exceed the Maximum Contaminant Level at the seepline) and the peak doses would persist for a very long time due to the release of other radiological constituents from the saltstone.

The results for alpha-emitting radionuclides shown in Tables 4.2.2-4 through 4.2.2-5 also show that the greatest long-term impacts would occur for the No Action Alternative. For this alternative, the Maximum Contaminant Level is exceeded at the 1-meter and 100-meter wells. The grout, sand, and saltstone fill options show similar impacts at all most locations. For these three options, the Maximum Contaminant Level for alpha-emitting radionuclides would be exceeded only at the 1-meter well (all three options) and at the 100-meter well (Clean and Fill with Sand Option).

The non-radiological results presented in Tables 4.2.2-6 through 4.2.2-8 show a consistent trend for all points of exposure. Unlike the radiological results, however, the data show exceedances of the Maximum Contaminant Levels only for the No Action Alternative and Clean and Fill with Saltstone Option. The impacts are greatest in terms of the variety of contaminants that exceed the Maximum Contaminant Level for the No Action Alternative, but exceedances of the Maximum Contaminant Levels primarily occur at the 1-meter well. Impacts from the Clean and Fill with Saltstone Option occur at all exposure points, including the seepline; however, nitrate is the only contaminant that exceeds the Maximum Contaminant Level. This occurs because the saltstone would contain large quantities of nitrate that would not be present in the tank residual. The Maximum Contaminant Levels are not exceeded for any contaminant in any aquifer layer, at any point of exposure, for either the Clean and Fill with Grout or the Clean and Fill with Sand Options.

4.2.3 ECOLOGICAL RESOURCES

This section presents an evaluation of the potential long-term impacts of F- and H-Area Tank Farm closure to ecological receptors. DOE assessed the potential risks to ecological receptors at groundwater points of discharge (seeplines) to Upper Three Runs and Fourmile Branch, and the risks to ecological receptors in these streams downstream of the seeplines. This section presents a summary of this analysis; the detailed assessment is provided in Appendix C.

Groundwater-to-surface water discharge of tank farm-related contaminants was the only migration pathway evaluated because the closed tanks would be 4 to 7 meters underground, precluding overland runoff of contaminants and associated terrestrial risks. As a result, only aquatic and semi-aquatic receptors and associated risks were evaluated.

The habitat in the vicinity of the seeplines is bottomland hardwood forest. On the upslope side of the bottomland, the forest becomes a mixture of pine and hardwood.

The estimated 1.24 acre seepage areas are small, (DOE 1997a), so risk to plant populations would be negligible even if individual plants were harmed. The only case in which harm to individual plants might be a concern in such a small area would be if protected plant species are present. Because no protected plant species are known to occur in these areas, risks to terrestrial plants are not treated further in the risk assessment.

4.2.3.1 Non-radiological Contaminants

Exposure for aquatic receptors (e.g., fish, aquatic invertebrates) is expressed as the concentration of contaminants in the water surrounding them. Sediment can become contaminated from the influence of the surface water or from seepage that enters sediment directly. However, this exposure medium was not evaluated because estimating sediment contamination from surface water inputs would be highly speculative and seepage into sediment is not considered in the groundwater model; all of the transported material is assumed to come out at the seeplines. For aquatic receptors, risks were evaluated by comparing concentrations of contaminants in surface water downgradient of seeps with ecological screening guidelines indicative of potential risks to aquatic receptors. Guidelines used are presented in Appendix C. If the ratio of the surface water concentration to the guideline (called the "hazard quotient") exceeded 1.0, risks to aquatic receptors were considered possible.

Exposure for terrestrial (semi-aquatic) receptors is based on dose, expressed as milligrams of contaminant absorbed per kilogram of body mass per day. For this evaluation, the southern short-tailed shrew and mink were selected as representative receptors (see Appendix C). The exposure routes used for estimating dose were ingestion of food and water. The food of shrews is mainly soil invertebrates, and the mink eats small mammals, fish, and a variety of other small animals. Contaminants in seepage water were considered to be directly ingested as drinking water (shrew); ingested as drinking water after dilution in Fourmile Branch and Upper Three Runs (mink); ingested in aquatic prey (mink); and transferred to soil, soil invertebrates, shrews, and to mink through a simple terrestrial food chain. The short-tailed shrew was assumed to receive exposure at the seepline only, and the mink was modeled as obtaining half of its diet from shrews at the seep area and the other half from aquatic prey downstream of the seepline. The bioaccumulation factor for soil and soil invertebrates is 1.0 for all inorganics, as is the factor for accumulation in shrew tissue. Literature-based bioconcentration factors were used to estimate chemical concentrations in aquatic prey for the mink (see Appendix C).

For the short-tailed shrew and the mink, toxicity thresholds are based on the lowest oral doses found in the literature that are no-observed-adverse-effect-levels (NOAELs) or lowest-observed-adverse-effect-levels (LOAELs) for chronic endpoints that could affect population viability or fitness (Appendix C). Usually the endpoints are adverse effects on reproduction or development. The exposure calculation is a ratio of total contaminant intake to body mass, on a daily basis. This dose is divided by the toxicity threshold value to obtain a hazard quotient. Similar to the ratio used for the aquatic receptors, risks were considered possible when the ratio of the estimated dose to the toxicity threshold (hazard quotient) exceeded 1.0.

Potential risks were evaluated for all of the analyzed scenarios, which are described in Appendix C. Each of the scenarios was evaluated using four methods for tank stabilization, which include the Clean and Fill with Grout Option, the Clean and Fill with Sand Option, the Clean and Fill with Saltstone Option, and the No Action Alternative (no stabilization). Comprehensive lists of all hazard quotients for each analyzed scenario are presented in Appendix C. Table 4.2.3-1 presents a summary of the maximum hazard indices (HIs) for aquatic receptors by tank stabilization method. Hazard quotients for individual aquatic contaminants were summed to obtain HIs. All HI values for the Clean and Fill with Sand and Saltstone Options were less than 1.0, indicating negligible risks to aquatic receptors in Fourmile Branch and Upper Three Runs. The maximum HIs for the Clean and Fill with Grout Option and No Action Alternative were slightly greater than 1.0. As a result, risks to aquatic receptors are possible. However, the relatively low HI values indicate that although risks are present, they are somewhat low. Although no guidance exists regarding the interpretation of the magnitude of HI values, given the conservation inherent in all aspects of the assessment single-digit HI values are most likely associated with low risks.

Table 4.2.3-2 presents a summary of the hazard quotients for the short-tailed shrew and mink by tank stabilization method. All terrestrial HQs were less than 1.0 for the grout, sand, and saltstone options, suggesting negligible risks to the shrew and mink (and similar species). The maximum HQ for silver for the No Action Alternative was slightly greater than 1.0. Hence, some risks are possible. Nevertheless, the relatively low maximum HQ suggests generally low risks.

As noted in Section 3.4, no Federally – listed species are known to occur in the vicinity of the F- and H-Area Tank Farms, and none have been recorded near the Upper Three Runs and Fourmile Branch seeplines. The American alligator (threatened due to similarity of appearance to the American crocodile) is the only Federally – protected species that could potentially occur in the area of the seeplines. Given that no Federally – listed species are believed to be present and ecological risks to terrestrial and aquatic receptors are low, DOE does not expect any long-term impacts as a result of the proposed actions and alternatives.

4.2.3.2 <u>Radionuclides</u>

DOE calculated peak radiation dose to aquatic and terrestrial receptors at the seepline and receiving surface water from the tank closure alternatives. These radiation doses are compared to the limit of 1,000 millirad per day (365,000 millirad per year).

The following exposure pathways were chosen for calculating absorbed radiation dose to the terrestrial mammals of interest (shrew and mink) located on or near the seepline: ingestion of food (earthworms, slugs, insects and similar organisms for the shrew, and shrews for the mink); ingestion of soil; and ingestion of water. The following exposure pathways were chosen for calculating absorbed dose to aquatic animals of interest (sunfish) living in Fourmile Branch and Upper Three Runs: uptake of contaminants from water and direct irradiation from submersion in water. Standard values for parameters such as mass, food ingestion rate, water ingestion rate, soil ingestion rate, and bioaccumulation factors were used. Appendix C provides more details on the methodology and parameters used in this analysis.

Table 4.2.3-1. Summary of maximum hazard indices for the aquatic assessment by tank closure alternative.

No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option
Max. HI	Max. HI	Max. HI	Max. HI
2.0	1.42	0.18	0.16

Calculated absorbed doses to the referenced organisms are listed in Table 4.2.3-3. All calculated doses are below the regulatory limit of 365,000 millirad per year.

4.2.4 LAND USE

DOE's primary planning document for land use at SRS is the *Savannah River Site Future Land Use Plan* (DOE 1998). This plan (DOE 1998) analyzed several future use options, including residential future use. The residential use option would call for all of SRS, except for existing waste units with clean up decisions under RCRA or CERCLA that preclude residential use, to be cleaned up to levels consistent with residential land use. Clean up of SRS to levels required for residential use would result in enormous costs and considerable time commitment. Many areas at the site are contaminated at low levels with various contaminants and it is probably not feasible with current technology to remediate these areas to standards acceptable for residential development. An integral site future-use model that assumes no residential uses would be permitted in any area of the site was identified as the basis for SRS future-use planning.

The General Separations Area includes several nuclear material processing and waste management areas. In addition to the Tank Farms, this area includes the F- and H-Area canyon buildings, radioactive waste storage and disposal facilities, and the DWPF vitrification and salt processing facilities. This area also contains numerous as yet unremediated waste sites (basins, pits, piles, tanks, contaminated groundwater plumes). Soils and groundwater within the General Separations Area are contaminated with radionuclides and hazardous chemicals as a result of 40 years of site operations. As described in Section 3.2.2.4, several contaminants in groundwater (tritium and other radionuclides, metals, nitrates, sulfates, and chlorinated and volatile organics) currently exceed the applicable regulatory or DOE guidelines. This area of the SRS is least amenable to remediation to the levels that would enable future residential use.

Section 4.2.5 discusses impacts to humans using the land in or near the Tank Farms. DOE does not envision relinquishing control of this area. However, DOE recognizes that there is uncertainty in projecting future land use and effectiveness of institutional controls considered in this EIS. For purposes of analysis, DOE assumes direct physical control in the General Separations Area only for the next 100 years. In accordance with agreements with the State of South Carolina and as reflected in the *Industrial Wastewater Closure Plan for F- and H-Area High-Level Waste Tank Systems* (DOE 1996), DOE has calculated human health impacts based on doses that would be received over time at a point of compliance that is at the seepline, about a mile from the tank farms. However, recognizing the potential for exposure to groundwater and the fact that DOE's land use assumptions may be incorrect, DOE has also provided estimates of human health implications of doses that would be received directly adjacent to the boundary of the tank farm. This location is much closer to the tank farm than the point of compliance and the projected doses and consequent health effects are greater.

With respect to the 100-years of physical control, the land use plan establishes a future use policy for the SRS. Several key elements of that policy would maintain the tank farm area and exclude its future use from non-conforming land uses (see Figure 4.2.4-1). The most notable elements are the following:

- Protection and safety of SRS workers and the public shall be a priority.

Table 4.2.3-2. Summary of maximum hazard quotients for the terrestrial assessment by tank closure alternative.

	No Action Alternative		Clean and Stabilize Tanks Alternative					
			Clean and Fill with Grout Option		Clean Fill with Sand Option		Clean Fill with Saltstone Option	
	Max. HQ	Time of maximum exposure[a]	Max. HQ	Time of maximum exposure[a]	Max. HQ	Time of maximum exposure[a]	Max. HQ	Time of maximum exposure[a]
Aluminum	b	NA	b	NA	b	NA	b	NA
Barium	b	NA	b	NA	b	NA	b	NA
Chromium	0.04	4,235	0.02	3,955	b	NA	b	NA
Copper	b	NA	b	NA	b	NA	b	NA
Fluoride	0.20	105	0.08	105	0.01	105	0.01	1,015
Lead	b	NA	b	NA	b	NA	b	NA
Manganese	b	NA	b	NA	b	NA	b	NA
Mercury	b	NA	b	NA	b	NA	b	NA
Nickel	b	NA	b	NA	b	NA	b	NA
Silver	1.55	455	0.81	245	0.09	525	0.13	1,365
Uranium	b	NA	b	NA	b	NA	b	NA
Zinc	b	NA	b	NA	b	NA	b	NA

a. Years after closure.
b. HQ is less than 0.01
NA = Not applicable.

Table 4.2.3-3. Calculated maximum absorbed radiation dose to aquatic and terrestrial organisms by tank stabilization method (millirad/year).[a]

		Clean and Stabilize Tanks Alternative		
	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option
Sunfish dose	0.89	0.0038	0.0072	0.053
Shrew dose	24,450	24.8	244.5	460.5
Mink dose	2,560	3.3	25.6	265

a. DOE limit is 365,000 millirad per year.

- The integrity of site security shall be maintained.
- A "restricted use" program shall be developed and followed for special areas (e.g., CERCLA and RCRA regulated units).
- SRS boundaries shall remain unchanged, and the land shall remain under the ownership of the Federal government.
- Residential uses of all SRS land shall be prohibited in any area of the site.

In principle, industrial zones are ones in which the facilities pose either a potentially significant nuclear or non-nuclear hazard to employees or the general public. In the case of the Industrial-Heavy Nuclear zone, the facilities included (1) produce, process, store and/or dispose of radioactive liquid or solid waste, fissionable materials, or tritium; (2) conduct separations operations; (3) conduct irradiated materials inspection, fuel fabrication, decontamination, or recovery operations; or (4) conduct fuel enrichment operations (DOE 1998).

The future condition of the F- and H-Area Tank Farms would vary among the alternatives. Under the No Action Alternative, structural collapse of the tanks would create unstable ground conditions and form holes into which workers or other site users could fall. Neither the Clean and Stabilize Tanks Alternative nor the Clean and Remove Tanks Alternative would have this safety hazard, although there could be some moderate ground instability with the Clean and Fill with Sand Option. For the Clean and Stabilize Tanks Alternative, four tanks in F-Area and four tanks in H-Area would require backfill soil to be placed over the top of the tanks. The backfill soil would bring the ground surface at these tanks up to the surrounding surface elevations to prevent water from collecting in the surface depressions. This action would prevent ponding conditions over these tanks that could facilitate the degradation of the tank structure. For the Clean and Remove Tanks Alternative, the tank voids remaining after excavation would be filled in. The backfill material would consist of a soil type similar to the soils currently surrounding the tanks.

4.2.5 PUBLIC HEALTH

This section presents the potential impacts on human health from residual contaminants remaining in the HLW tanks after closure following the period of institutional control of the H-Area and F-Area Tank Farms.

To determine the long-term impacts, DOE has reviewed data for both tank farms, including the following:

- Expected source inventory that would remain in the tanks
- Existing technical information on geological and hydrogeological parameters in the vicinity of the tank farms

Use of the land around the tank farms

- Arrangement of the tanks within the stratigraphy
- Actions to be completed under each of the alternatives

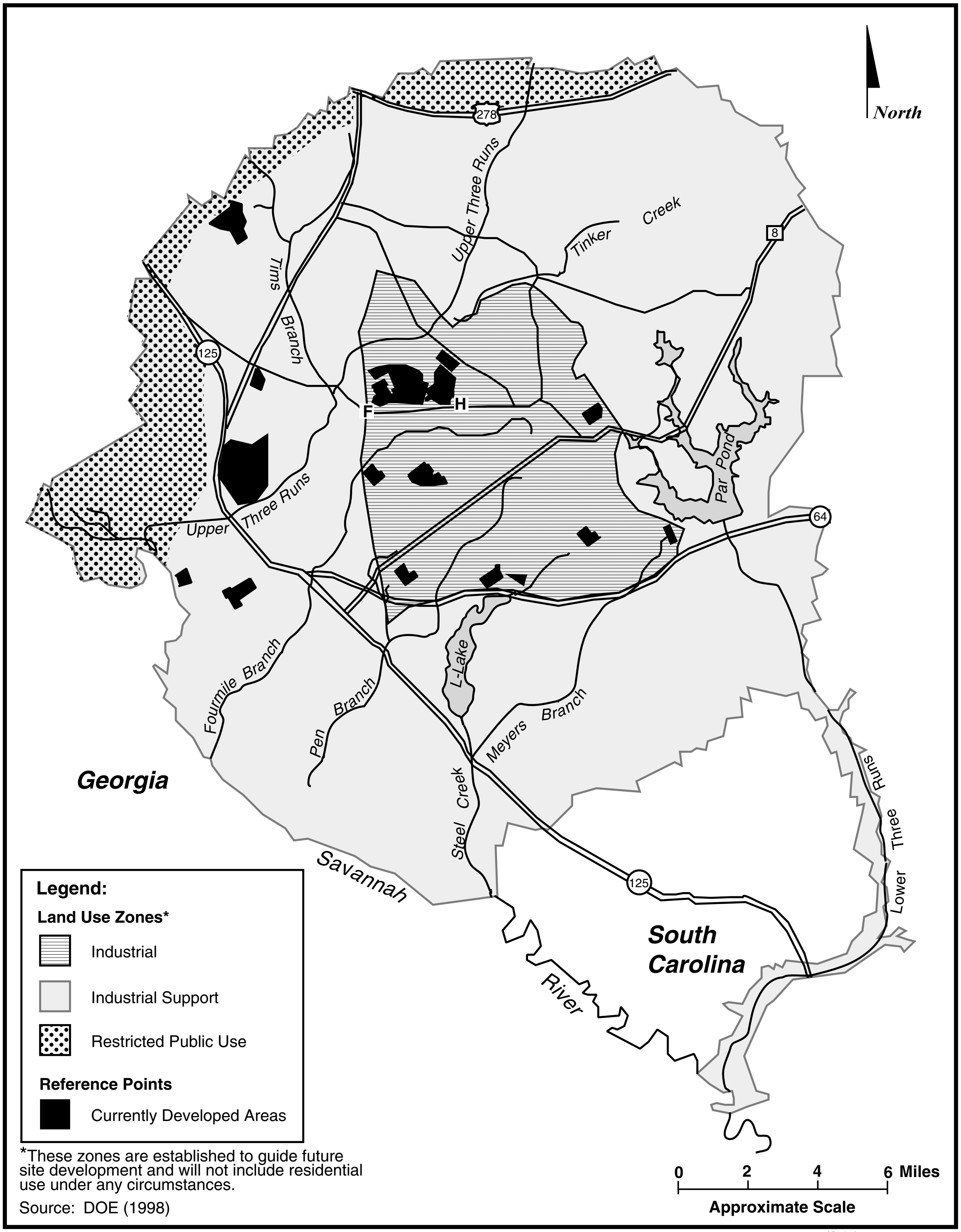

Figure 4.2.4-1. Savannah River Site land use zones.

In its evaluation, DOE has reviewed the human populations who could be exposed to contaminants from the tank farms and has identified the following hypothetical individuals:

- *Worker*: an adult who has authorized access to, and works at, the tank farm and surrounding areas. This analysis assumes that the worker remains on the shores of Fourmile Branch or Upper Three Runs during working hours. This assumption maximizes the hypothetical worker's exposure to contaminants that might emerge at the seepline.

- *Intruder*: a person who gains unauthorized access to the tank farm and is potentially exposed to contaminants.

- *Nearby adult resident*: an adult who lives in a dwelling across either Fourmile Branch or Upper Three Runs downgradient of the tank farms, near the stream.

- *Nearby child resident*: a child who lives in a dwelling across either Fourmile Branch or Upper Three Runs downgradient of the tank farms, near the stream.

- *Downstream resident*: a person who lives in a downstream community where residents get their household water from the Savannah River. Effects are estimated for an average individual in the downstream communities and for the entire population in these communities.

DOE has based the assessment of population health effects on present-day populations because estimation of future populations is very speculative. The analysis based on present-day populations is useful for the purpose of understanding the potential impacts of the proposed action on future residents of the region.

DOE evaluated the impacts over a 10,000-year period, which is consistent with the time period used previously in the *Industrial Wastewater Closure Plan for F- and H-Area High Level Waste Tank System*. Because the tanks are located below the grade of the surrounding topography, DOE does not expect any long-term airborne releases to occur from the tanks. Therefore, DOE based its calculations on postulated release scenarios whereby contaminants in the tanks would be leached from the tank structures and transported to the groundwater. However, the holes formed by the collapsed tanks under the No Action Alternative would pose a long-term safety hazard.

As discussed in Section 4.2.2, the aquifers in the vicinity of F-Area Tank Farm and H-Area Tank Farm outcrop along both Fourmile Branch and Upper Three Runs. Because the locations where these aquifers outcrop from the tank farms do not overlap, DOE has chosen to calculate and present the impacts for these hypothetical individuals separately for F-Area Tank Farm and H-Area Tank Farm.

In addition to the hypothetical individuals and population listed above, DOE also calculated the concentration of contaminants in groundwater at the location where the groundwater outcrops into the environment (i.e., the seepline) and at 1 meter and 100 meters downgradient from each of the tank farms. Discussion of these results is provided in Section 4.2.2, along with an estimate of the impacts from pathways at these locations.

For non-radiological constituents, DOE compared the water concentrations directly to the concentrations listed as Maximum Contaminant Levels in 40 CFR 141. Appendix C lists concentrations for all the nonradiological constituents. As discussed in Section 4.2.2, DOE has chosen to present the fractions of Maximum Contaminant Level for non-radiological constituents to enable quantitative comparison among the alternatives.

As discussed in Appendix C, DOE performed its calculations for the three uppermost aquifers underneath the General Separations Area; however, in this section, DOE presents only the maximum results for the two tank farms. In addition, the maximum results for H-Area Tank Farm are reported, independent of which seepline (Upper Three Runs or Fourmile Branch) receives the highest level of contaminants. Downstream Savannah River users are assumed to be exposed to contemporaneous releases from all aquifers and seeplines. Further details on aquifer-specific results can be found in Appendix C.

Tables 4.2.5-1, 4.2.5-2, and 4.2.5-3 show the radiological results for the F- and H-Area Tank Farms. The maximum annual dose to the adult resident for either tank farm is 6.2 millirem per year for the No Action Alternative. This dose is less than the annual 100 millirem public dose limit and represents only a marginal increase in the annual average exposure of individuals in the United States of approximately 360 mrem due to natural sources of radiation exposure, as discussed in Section 3.8. Based on this low dose, DOE would not expect any health effects if an individual were to receive the dose calculated for the hypothetical adult.

DOE considered, but did not model, the potential exposures to people who live in a home built over the tanks at some time in the future when they are unaware that the residence was built over closed waste tanks. DOE previously modeled this type of exposure for the saltstone disposal vaults in the Z Area. That analysis found that external radiation exposure was the only potentially significant pathway of potential radiological exposure other than groundwater use (WSRC 1992). Tables 4.2.2-4 and 4.2.2-5 present estimates of the radiological doses from drinking water from the close-in wells where onsite residents might obtain their water. DOE also projected the contribution of other water-related environmental pathways to one set of model output and concluded that the dose to a future resident from these other pathways would not exceed the drinking water dose by more than 20 percent. For the Clean and Fill with Grout and Clean and Fill with Sand Options of the Clean and Stabilize Tanks Alternative, external radiation doses to onsite residents would be negligible because the thick layers of nonradioactive material between the waste (near the bottom of the tanks) and the ground surface would shield residents from any direct radiation emanating from the waste. External radiation exposures could occur under the Clean and Fill with Saltstone Option which would place radioactive saltstone near the ground surface. If it is conservatively assumed that all of the backfill soil is eroded or excavated away and there is no other cap over the saltstone, so that a home is built directly on the saltstone, analysis presented in WSRC (1992) indicates that 1000 years after tank closure a resident would be exposed to an effective dose equivalent of 390 mrem/year, resulting in an estimated 1 percent increase in risk of latent cancer fatality from a 70-year lifetime of exposure. Backfill soils or caps would eliminate or substantially reduce the potential external exposure. For example, with a 30-inch-thick intact concrete cap, the dose would be reduced to 0.1 mrem/year. For the No Action Alternative external exposures to onsite residents would be expected to be unacceptably high due to the potential for contact with the residual waste.

At the one-meter well, the highest calculate peak drinking water dose under the No Action Alternative is 9,300,000 millirem per year (9,300 rem per year), which would lead to acute radiation health effects, including death. Peak doses at this well for the Clean and Stabilize Tanks Alternative are calculated to be in the range of 100,000 to 130,000 millirem per year (100 to 130 rem per year), which substantially exceeds all criteria for acceptable exposure, could result in acute health effects, and would give a significantly increased probability of a latent cancer fatality. Peak doses calculated at the 100-meter well range from 300 millirem (0.3 rem per year) per year for the Clean and Fill with Grout Option to 90,000 millirem per year (90 rem per year) for the No Action Alternative. Individuals exposed to 300 millirem per year would experience a lifetime increased risk of latent cancer fatality of less that 0.02 percent per year of exposure. The estimated doses at the 1- and 100-meter wells are extremely conservative (high) estimates because the analysis treated all of the tanks in a given group as being at the same physical location. Realistic doses at these close-in locations would be substantially smaller. As noted above, land-use controls and other institutional control measures would be employed to prevent exposure at these locations.

Table 4.2.5-1. Radiological results from contaminant transport from F-Area Tank Farm.[a]

	Clean and Stabilize Tanks Alternative			
	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
Adult resident maximum annual dose (millirem per year)	0.027	0.051	0.37	6.2
Child resident maximum annual dose (millirem per year)	0.024	0.047	0.34	5.7
Seepline worker maximum annual dose (millirem per year)	(c)	(c)	0.001	0.018
Intruder maximum annual dose (millirem per year)	(c)	(c)	(c)	9.0×10^{-3}
Adult resident maximum lifetime dose (millirem)[b]	1.9	3.6	26	430
Child resident maximum lifetime dose (millirem)[b]	1.7	3.3	24	400
Seepline worker maximum lifetime dose (millirem)[d]	0.002	0.004	0.03	0.54
Intruder maximum lifetime dose (millirem)[d]	0.001	0.002	0.02	0.27
Adult resident latent cancer fatality risk	9.5×10^{-7}	1.8×10^{-6}	1.3×10^{-5}	2.2×10^{-4}
Child resident latent cancer fatality risk	8.5×10^{-7}	1.7×10^{-6}	1.2×10^{-5}	2.0×10^{-4}
Seepline worker latent cancer fatality risk	8.0×10^{-10}	1.6×10^{-9}	1.2×10^{-8}	2.2×10^{-7}
Intruder latent cancer fatality risk	4.0×10^{-10}	8.0×10^{-10}	8.0×10^{-9}	1.1×10^{-7}
1-meter well drinking water dose (millirem per year)	130	420	790	3.6×10^{5}
1-meter well alpha concentration (picocuries per liter)	13	13	13	1,700
100-meter well drinking water dose (millirem per year)	51	190	510	1.4×10^{4}
100-meter well alpha concentration (picocuries per liter)	4.8	4.7	4.8	530
Seepline drinking water dose (millirem per year)	1.9	3.5	25	430
Seepline alpha concentration (picocuries per liter)	0.04	0.039	0.04	9.2
Surface water drinking water dose (millirem per year)	9.8×10^{-3}	0.019	0.13	2.3

a. The Clean and Remove Tanks Alternative is not presented in this table because the residual waste (and tank components) would be removed from the Tank Farm areas and transported to SRS radioactive waste disposal facilities. The environmental impacts of these disposal facilities were analyzed in the SRS Waste Management EIS (DOE 1995), Section 4.2.3.
b. Lifetime of 70 years assumed for this individual.
c. The radiation dose for this alternative is less than 1×10^{-3} millirem.
d. Lifetime of 30 years assumed for this individual.

Table 4.2.5-2. Radiological results from contaminant transport from H-Area Tank Farm.[a]

	Clean and Stabilize Tanks Alternative			
	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
Adult resident maximum annual dose (millirem per year)	0.010	0.016	0.19	2.4
Child resident maximum annual dose (millirem per year)	9.3×10^{-3}	0.015	0.18	2.2
Seepline worker maximum annual dose (millirem per year)	(c)	(c)	(c)	7×10^{-3}
Intruder maximum annual dose (millirem per year)	(c)	(c)	(c)	3.5×10^{-3}
Adult resident maximum lifetime dose (millirem)[b]	0.7	1.1	13	170
Child resident maximum lifetime dose (millirem)[b]	0.65	1.1	1.3	150
Seepline worker maximum lifetime dose (millirem)[d]	(c)	0.001	0.017	0.21
Intruder maximum lifetime dose (millirem)[d]	(c)	(c)	0.008	0.11
Adult resident latent cancer fatality risk	3.9×10^{-7}	5.5×10^{-7}	6.5×10^{-6}	8.5×10^{-5}
Child resident latent cancer fatality risk	3.3×10^{-7}	5.5×10^{-7}	6.5×10^{-7}	7.5×10^{-5}
Seepline worker latent cancer fatality risk	(e)	4.0×10^{-10}	6.8×10^{-9}	8.4×10^{-8}
Intruder latent cancer fatality risk	(e)	(e)	3.2×10^{-9}	4.4×10^{-8}
1-meter well drinking water dose (millirem per year)	1×10^{5}	1.3×10^{5}	1.0×10^{5}	9.3×10^{6}
1-meter well alpha concentration (picocuries per liter)	24	290	24	13,000
100-meter well drinking water dose (millirem per year)	300	920	870	9.0×10^{4}
100-meter well alpha concentration (picocuries per liter)	7.0	38	7.0	3,800
Seepline drinking water dose (millirem per year)	2.5	25	46	2.5×10^{3}
Seepline alpha concentration (picocuries per liter)	0.15	0.33	0.15	34
Surface water drinking water dose (millirem per year)	3.7×10^{-3}	6.0×10^{-3}	0.071	0.90

a. The Clean and Remove Tanks Alternative is not presented in this table because the residual waste (and tank components) would be removed from the Tank Farm areas and transported to SRS radioactive waste disposal facilities. The environmental impacts of these disposal facilities were analyzed in the SRS Waste Management EIS (DOE 1995), Section 4.2.3.
b. Lifetime of 70 years assumed for this individual.
c. The radiation dose for this alternative is less than 1×10^{-3} millirem.
d. Lifetime of 30 years assumed for this individual.

Table 4.2.5-3. Radiological results to downstream resident from contaminant transport from F- and H-Area Tank Farms.[a]

	Clean and Stabilize Tanks Alternative			
	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
Downstream maximum individual annual dose (millirem per year)	(b)	(b)	(b)	(b)
Downstream maximum individual lifetime dose (millirem)	(b)	(b)	3.4×10^{-3}	4.1×10^{-2}
Downstream maximum individual latent cancer fatality risk	(c)	(c)	1.8×10^{-9}	2.1×10^{-8}
Population dose (person-rem per year)	8.6×10^{-5}	3.3×10^{-4}	3.4×10^{-3}	4.1×10^{-2}
Population latent cancer fatality risk (incidents per year)	4.3×10^{-8}	1.7×10^{-7}	1.8×10^{-6}	2.1×10^{-5}

a. The Clean and Remove Tanks Alternative is not presented in this table because the residual waste (and tank components) would be removed from the Tank Farm areas and transported to SRS radioactive waste disposal facilities. The environmental impacts of these disposal facilities were analyzed in the SRS Waste Management EIS (DOE 1995), Section 4.2.3.
b. The radiation dose for this alternative is less than 1×10^{-3} millirem.
c. The risk for this alternative is very low, less than 10^{-9}.

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